NOT TO BE ISSU
OUT OF THE LI RY.

00053322

Digitized with financial assistance from

Shri Brihad Bhartiya Samaj

on 20 February, 2020

THE WORKS

OF THE HONOURABLE

ROBERT BOYLE.

In FIVE VOLUMES.

To which is prefixed

The LIFE of the AUTHOR.

VOLUME I.

[redacted]22
a.c.

LONDON:
Printed for A. MILLAR, oppoſite *Catharine-Street*, in the *Strand*.
MDCCXLIV.

1744

God is
921.2
Boy/Boy/Mor
53322

TO THE

RIGHT HONOURABLE

RICHARD

Earl of BURLINGTON and CORK,

Baron CLIFFORD of *Londeſburgh*,

AND

Baron CLIFFORD,

Baron BOYLE of *Youghall*,

AND

Viſcount DUNGARVAN,

One of the Lords of his Majeſty's moſt honourable Privy Council,

AND

Knight of the moſt noble Order of the Garter.

My LORD,

THIS addreſs is ſo much a debt to your LORDSHIP, that the omiſſion of it would have been abſolutely inexcuſable. For to whom could the Works of the ever honourable Mr. BOYLE be preſented with ſo much propriety, as to the head of that ILLUSTRIOUS FAMILY, to which he was ſo great an ornament? Or with what gratitude or juſtice could theſe acknow-

ledgments be ſuppreſſed, for your LORDSHIP's generous encouragement and aſſiſtance, which ſo greatly contributed to oblige the world with theſe Works in the preſent form? Theſe peculiar circumſtances render it the leſs neceſſary for me to inſiſt upon the more general conſiderations of that high regard, which every lover of polite or uſeful learning owes to your LORDSHIP, on account of your eminent ſkill in each of them, and your conſtant zeal for their promotion.

I am,

My LORD,

Your LORDSHIP's moſt obedient

and moſt devoted humble ſervant,

Andrew Millar.

THE PREFACE.

THE general reaſons for collecting into one body the works of the honourable *Robert Boyle* are as obvious, as the excellence of the ſeveral parts of them is univerſally acknowledged. It may ſuffice therefore to acquaint the reader, that as a complete ſet of thoſe before publiſhed is not perhaps to be found any where, except in the vaſt library of his learned friend Sir *Hans Sloane*, Bart. and as the whole contains a very large collection of philoſophical eſſays on a great variety of ſubjects, full of curious experiments and obſervations, with ſeveral valuable diſcourſes upon the moſt important ſubjects of religion: ſuch a collection had been long deſired, both for the public benefit, and as a juſtice due to the memory of that great reſtorer of the mechanical philoſophy; and is now executed in the following manner.

I. THE ſeveral tracts formerly printed are taken from the moſt improved editions with the utmoſt correctneſs, and diſpoſed in the order of time, in which they were firſt publiſhed. This diſpoſition of them was determined upon, as well from the reaſon of the thing, and with a view of ſhewing the riſe, progreſs, and dependencies of the Author's diſcoveries; as in conformity to his own judgment. Who, upon occaſion of a Latin edition of his works at *Geneva* in 1677, complained publicly by his friend Mr. *Oldenburg*, ſecretary of the Royal Society, in the *Philoſophical Tranſactions*, No. CXXX. p. 766, 767. "That the year in the "frontiſpiece of that edition is one and the ſame, as if the ſeveral books contained "in this Latin volume had been publiſhed in one year; and the enumeration of "the ſeveral treatiſes, made in the catalogue of this Latin edition, is not according "to the time, wherein they were firſt printed. For the *firſt* of the books mentioned in the ſaid catalogue was publiſhed in Engliſh *A.* 1660, the *fifth* and "*ſixth* A. 1661, the *ſecond* A. 1662, the *ſeventh* A. 1664, the *fourth* A. "1666, the *third* A. 1670, the *eighth* A. 1671, the *tenth* A. 1672, the *ninth* "A. 1673. So prepoſterouſly are thoſe books ranged in this catalogue and "volume: which the reader was to be informed of, that by comparing the ſeveral true dates of the firſt edition of this Author's works with the books of "others, ſince printed, the priority of the experiments and conſiderations, reſpectively contained in them, may be truly ſtated."

II. SOME very conſiderable additions are made in this edition, which were never before publiſhed; namely, fragments of an *Appendix* to the *firſt Part* of the *Chriſtian Virtuoſo*, and of the *ſecond Part* of that work, preſerved purſuant to the Author's own deſire; with a large collection of letters of Mr. *Boyle* and his friends upon various ſubjects, ſelected from about fifteen hundred written by moſt of the great men of the laſt age both at home and abroad, with whom he correſponded. Theſe additions the public owes to the reverend and learned Mr. *Henry Miles* of *Tooting* in *Surrey*, and F. R. S. who is poſſeſſed of thoſe manuſcripts of Mr. *Boyle*, which were put into his hands, with leave to make uſe of them for the public good, by the late worthy Mr. *Thomas Smith*, apothecary in the *Strand*, who lived ſeventeen years with Mr. *Boyle*, and was with him at his death; and which have been lately increaſed by a part of the original collection, that had been com-

municated

municated to Dr. *William Wotton*, author of *the Reflections upon ancient and modern Learning*, and were reſtored by his ſon in law the reverend Mr. *William Clarke*, canon reſidentiary of *Chicheſter*. Theſe manuſcripts are very numerous, but many of them written, while the Author was very young, and few completed. However I ſhall ſubjoin to the *Contents* the liſt of them as drawn up by his own order, all of them being ſtill extant, except thoſe marked with an aſteriſc before them.

III. THE copper-plates illuſtrating the ſeveral pieces are engraved with much greater exactneſs and elegance, than thoſe in any former edition.

IV. THERE being only two original pictures of Mr. *Boyle* now known to be extant, it was thought proper to have them both engraved. One, which repreſents him in the 38th year of his age, is placed in the title page of each volume, copied from a drawing of Mr. *Faithorne*, communicated by Sir *Hans Sloane*, from which likewiſe Mr. *Faithorne* himſelf engraved his print, with the inſtruments accompanying the head, according to the deſign of Dr. *Robert Hooke*, who thought the *face very carefully and well done, and very like*; as appears by his letters to Mr. *Boyle* of Auguſt 25, September 8, and December 15, 1664, printed in Vol. V. p. 534, 535, and 543, of this edition. The other, which fronts the title page of the firſt volume, is taken from an original painting done in the latter part of his life, and now in the collection of Dr. *Mead*.

V. THE *Life* contains Mr. *Boyle*'s own *Account of himſelf during his minority*, extending to the year 1642; and is continued to his death from the beſt materials, that could be procured at this diſtance of time, and without moſt of thoſe advantages, which Dr. *Burnet* biſhop of *Saliſbury*, and Dr. *William Wotton*, who had the ſame deſign near fifty years ago, might have obtained for the execution of it. The only qualities I can engage for are induſtry and fidelity; but the genius and abilities of a *Gaſſendus* would be requiſite to do juſtice to a character ſuperior even to that of the celebrated *Peireſkius*.

I MUST not conclude this preface without returning my ſincereſt acknowledgments to Mr. *Miles* abovementioned, to whoſe great labour, judgment, and ſagacity, the conduct and improvements of this edition are chiefly to be aſcribed; and to Mr. *John Ward*, profeſſor of rhetoric at *Greſham* college, whoſe advice and aſſiſtance I have found extremely ready and uſeful to me upon this and all other occaſions.

THOMAS BIRCH.

London, Nov. 16, 1743.

THE

A

LIST

OF

The ENCOURAGERS to the WORKS

OF

The Honourable *Robert Boyle.*

A.

HIS Grace the Duke of *Argyle.*
His Grace the Duke of *Athol,* large Paper.
The Right Honourable the Earl of *Aileſbury.*
Sir *Jacob Aſtley,* Bart. large Paper.
Sir *John Anſtruther,* Bart. large Paper.
The Honourable *Richard Arundel,* Eſq;
Stephen Adye, Eſq; of *St. Chriſtopher's,* large Paper.
John Armſtrong, M. D.
James Abercromby, Eſq; Attorney-General of *South Carolina.*

B.

The Right Honourable the Earl of *Burlington,* large Paper.
The Right Honourable the Earl of *Buchan.*
The Right Honourable the Earl of *Bute.*
The Right Honourable the Lord *Brooke,* large Paper.
The Right Honourable the Lord *Blantyre.*
The Right Honourable the Lord Viſcount *Barrington.*
The Honourable Miſs *Boyle,* large Paper.
Sir *John Bruce Hope,* Bart.
Sir *Thomas Brand,* Knt.
The Honourable Judge *Burnet.*
The Honourable *George Brydges,* Eſq;
Reverend *Philip Bearcroft,* D. D.
Edward Barry, M. D. in *Dublin.*
Benjamin Bocanquet, M. D.
Col. *William Byrd* in *Virginia.*
William Briſtow, Eſq; large Paper.
Rev. Mr. *Lewis Bruce,* Preacher at *Somerſet* Chapel.
William Blair, Eſq;
Edward Bayntun Rolt, Eſq;
John Barker, M. D.
John Bloſs, Eſq;
Mr. *Brymer,* Bookſeller, in *Edinburgh.*
Mr. *Barry,* Bookſeller, in *Glaſgow.*

C.

The Right Honourable the Earl of *Cheſterfield.*
The Right Honourable the Earl of *Cholmondley,* large Paper.
The Right Honourable the Earl of *Crawford.*
The Right Honourable the Lord *Carteret,* large Paper.
The Right Honourable the Lord *Conway,* large Paper.
The Right Honourable the Lord *Clinton.*
The Right Honourable the Lord *Charles Cavendiſh.*
Henry Cliff, Eſq;
Rev. Mr. *John Colt,* LL. B. of *Lanivitt* in *Cornwall.*
Robert Crammond, Eſq; Merchant in *Peterſburgh.*
George Crump, M. D.
Rev. Mr. *Samuel Chandler.*

D.

His Grace the Duke of *Devonſhire,* large Paper.
The Right Honourable the Lord Viſcount *Dupplin.*
The Right Honourable the Lord *Dunkerron,* large Paper.
Right Rev. *Thomas,* late Lord Biſhop of *Derry,* large Paper.

Sir *James Daſhwood*, Bart. large Paper.
Rev. *Patrick Delany*, D. D.
John Douglas, Eſq; of *St. Chriſtopher's.*
George Doddington, Eſq;
Robert Dinwiddie, Eſq; Surveyor General in *America.*
Archibald Duff, of the *Inner Temple*, Eſq;
William Draper, Eſq;
The late *James Douglas*, M. D.
John Dodd, Eſq;
Rev. Mr. *Hugh Deans* in *Maryland.*

E.

The Right Honourable the Earl of *Eglington.*
Charles Ecklin, Eſq;
James Erſkine, Eſq;
Major *Edwards.*

F.

The King of *France*'s Library, large Paper.
The Right Honourable the Earl of *Findlater* and *Seafield*, large Paper.
The Right Honourable Greffier *Fagel* at the *Hague.*
Martin Folkes, Eſq; Preſident of the Royal Society, large Paper.
William Fitzherbert, Eſq;
Thomas Foſter, Eſq;
Rev. Mr. *Fowler*, large Paper.
Rev. Mr. *Philip Francis.*
Mr. *Bernard Frederick.*
Mr. *Thomas Farr*, Attorney at Law in *Briſtol.*
Meſſieurs *Foulis*, at *Glaſgow.*

G.

His Grace the Duke of *Gordon*, large Paper.
Sir *James Grant*, Bart.
The Honourable *James Gordon*, Eſq; Chief Judge of *St. Chriſtopher's.*
King Gould, Eſq;
Philips Glover, Eſq; F. R. S.
Dr. *William Gibbons* of *St. Chriſtopher's*, large Paper.
Levin Gale of *Maryland*, Eſq;
John Gray, Eſq; in *Jamaica.*

H.

His Grace the Duke of *Hamilton*, large Paper.
The Right Honourable the Earl of *Harrington.*
The Right Honourable the Earl of *Holderneſs.*
The Right Honourable the Earl of *Home.*
The Right Honourable the Earl of *Hoptoun*, large Paper.
The Right Honourable the Lord Viſcount *Hillsborough.*
The Right Honourable the Lord Viſcount *Harcourt.*
Sir *James Hamilton* of *Roſe-hall*, Bart.
The Honourable *John Hay* of *Lawfield*, Eſq;
William Hamilton of *Lincolns-Inn*, Eſq;
Rev. *Obadiah Hughes*, D. D.
Mr. *Brown Huſton.*

I.

Sir *Theodore Janſſen*, Bart.
Gabriel Johnſton, Eſq; Governor of *North Carolina.*
John Jolliff, Eſq;
Joſhua Iremonger, of *Whorwell* in *Hampſhire*, Eſq;
Charles Jennens, Eſq;
William Jones, Eſq; F. R. S.
St. John's College Library, *Oxford.*

K.

His Grace the Duke of *Kingſton.*
The Right Honourable the Lord *King.*
The Honourable General *Keith.*
Rev. Mr. *Kinroſs*
Mr. *Alexander Kincaid*, Bookſeller in *Edinburgh.*

L.

The Right Honourable the Earl of *Loudoun.*
The Right Rev. *Edmund* Lord Biſhop of *London.*
The Honourable General *Ligonier.*
Col. *Thomas Lee* in *Virginia.*
Henry Lintot, Eſq;
Dr. *John Lining*, in *South Carolina.*
Rev. *Thomas Lewis*, A. M.
William Lewis, M. B.

M.

His Grace the Duke of *Marlborough*, large Paper.
His Grace the Duke of *Montroſe.*
The Right Honourable the Earl of *Morton*, large Paper.

The

The Right Honourable the Earl of *Macclesfield.*
The Right Honourable the Lord *Malton,* large Paper.
The Right Honourable the Lord *Monſon.*
The Right Honourable the Lord *Manſel.*
Richard Mead, M. D. large Paper.
Mr. *Colin Mac-Laurin,* Profeſſor of Mathematics in the Univerſity of *Edinburgh,* and F. R. S.
The Honourable *Charles Maynard,* Eſq; large Paper.
The Honourable *James Stewart Mackinzie,* Eſq;
Andrew Mitchell, Eſq; large Paper.
William Morehead, Eſq; large Paper.
William Monck, of the *Middle Temple,* Eſq;
Norman Mac-Cleod, Eſq;
William Mure of *Caldwell,* Eſq;
Henry Montague, of *Lincoln's-Inn,* Eſq;
Benjamin Martin, Eſq;
Samuel Martin, Eſq;
James Mounſey, M. D. of *Peterſburgh.*
Mr. *William Maitland,* F. R. S.
Rev. Mr. *Robert Millar* in *Paiſley.*
Rev. Mr. *Henry Miles* of *Tooting,* F. R. S. large Paper,
Dr. *William Millar* in *Antigua.*
Mr. *Alexander Mac-Farlane,* Merchant in *Jamaica.*

N.

His Grace the Duke of *Newcaſtle.*
Edward Northey, Eſq;
Robert Nugent, Eſq;

O.

The Right Honourable the Earl of *Orrery,* large and ſmall Paper.
The Right Honourable the Earl of *Orford,* large Paper.
The Right Honourable *Arthur Onſlow,* Eſq; Speaker of the Houſe of Commons, large Paper.
Samuel Ogle, Eſq; late Governor of *Maryland.*

P.

His Grace the Duke of *Portland.*
Richard Plumpton, Eſq; large Paper.
Ralph Payne, Eſq; of *St. Chriſtopher's.*
Thomas Paterſon, Eſq;
Dr. *James Penman.*
Dr. *Pile.*
Rev. Mr. *Edward Paterſon.*
Mr. *Pringle,* Surgeon.

Q.

His Grace the Duke of *Queensberry,* large Paper.

R.

His Grace the Duke of *Roxborough,* large Paper.
The Right Honourable the Earl of *Rothes.*
The Right Honourable the Lord *Raymond.*
The Honourable *William Roſs,* Eſq;
David Roſs, M. D.
Andrew Reid, Eſq;
John Ranby, Eſq;

S.

The Right Honourable the Earl of *Stair,* large Paper.
The Right Honourable the Earl *Stanhope,* large Paper.
The Right Honourable the Earl of *Shafteſbury.*
Sir *Hans Sloane,* Bart. large Paper.
The Right Honourable *Samuel Sandys,* Eſq; Chancellor of the Exchequer.
Charles Stanhope, Eſq; F. R. S.
George Lewis Scott, Eſq; F. R. S.
William Strode, Eſq;
George Sinclair of *Ulbſter,* Eſq;
Wayvil Smith, Eſq; Secretary to the *Leeward Iſlands.*
Henry Slingsby, Eſq; in *Barbadoes.*
Dr. *Stewart* of *Annapolis* in *Maryland.*
Peter Shaw, M. D.
Mr. *Sergeant.*
Rev. Mr. *Swinton,* A. M. Fellow of *Wadham College, Oxford.*
Rev. Mr. *Spateman.*
Mr. *John Smith,* Bookſeller in *Dublin.*

T.

The Moſt Honourable the Marquis of *Tweeddale,* large Paper.
The Right Honourable the Lord *Talbot.*
Sir *John Turner,* Bart. large Paper.

Philip

Philip Thomas, Eſq; of *Annapolis* in *Maryland*.
Peter Templeman, M. D.
Mr. *William Templeman*.

U.

Univerſity of *St. Andrew's*.
Univerſity of *Glaſgow*.
John Upton, Eſq;
Mrs. *Sarah Unett*, Bookſeller in *Woolverhampton*.

W.

The Right Honourable the Earl of *Warrington*.
The Right Honourable the Earl of *Wemyſs*.
The Right Rev. *Iſaac* Lord Biſhop of *Worceſter*.
The Honourable *Edward Walpole*, Eſq;
Lee Warner, Eſq; large Paper.
John White, Eſq;
Taylor White, of *Lincoln's-Inn*, Eſq;
John Williams, Eſq;
James Williamſon, Eſq;
William Wood, Eſq; Secretary to the Cuſtoms.
James Weatherill, Eſq; of *Antigua*.
Mr. Profeſſor *Ward* of *Greſham College*, F. R. S.
James Weſt, of *Lincoln's-Inn*, Eſq;
Richard Warner, of *Lincoln's-Inn*, Eſq;
Rev. Mr. *George Wiſhart*.
Mr. *Robert Weems*, Surgeon in *Oporto*.
Mr. *Thomas Wright*.

Y.

Shute Yeamans, Eſq;

THE

LIFE

Of the honourable

ROBERT BOYLE.

By *THOMAS BIRCH*, M. A. and F. R. S.

THE honourable *Robert Boyle* was deſcended from a family, whoſe name before the conqueſt was written *Biuvile*. The firſt footing, that we find of them in the county of *Hereford*, was at *Pixely* court, near *Ledbury*, of which *Humfrey de Biuvile* was lord, as is recorded in Doom's-day book, *tit.* 28. *Terra Humfridi de Biuvile in Radelau Hund. Humfridus de Biuvile tenet de Rege Pichelei Auſhil tenuit.* Theſe words *Auſhil tenuit*, in the general conſtruction of antiquaries, import, that it was in the time of *Edward* the Confeſſor *(a)*.

Lodowick Boyle (*b*), who lived in the reign of king *Henry* III. was father of *John Boyle*, and he of *James*, who had iſſue *Lodowick*, whoſe ſon was ſucceeded by *James* his ſon and heir, father (*c*) of *Lodowick Boyle* of *Bidney*, and of the Friers in the city of *Hereford*, in the reign of king *Henry* VI. This *Lodowick* married *Elizabeth*, daughter of *William Ruſſel*, Eſq; and had iſſue (*d*) a daughter, *Eleanor*, married to *Watkin Ruſſel*, and two ſons, *John Boyle*, Eſq; who had the eſtate in *Herefordſhire*, and *Roger Boyle*, ſecond ſon. This *Roger* married *Jane*, daughter of *Thomas Pattiſhal* of the county of *Hereford*, and had iſſue *John Boyle* of *Hereford*, *Roger*, ſecond ſon, and *Michael Boyle* of *London*, third ſon, who left a numerous iſſue, whereof *Richard*, his ſecond ſon, was biſhop of *Corke* and *Roſs*, being allowed alſo to keep the See of *Cloyne* in commendam, was afterwards archbiſhop of *Tuam*, and died March 19, 1644. He left iſſue *Michael Boyle*, archbiſhop of *Armagh*, and lord chancellor of *Ireland*, who died, aged 93, in the year 1702, and was father to *Murrough Boyle*, created lord viſcount *Bleſſington*. *Michael*, another ſon of the ſaid *Roger*, was biſhop of *Waterford* and *Liſmore*; and Sir *George Boyle*, his fourth ſon, died without iſſue. *Roger Boyle*, the ſecond ſon, married *Joan*, daughter of *John Naylor* of *Kenvile* in the county of *Kent*, and had iſſue *John Boyle*, biſhop of *Corke* and *Roſs* in *Ireland*; *Richard Boyle*, ſecond ſon, earl of *Corke*, and father of that great man, of whom I am to treat; *Hugh Boyle*, third ſon, who died without iſſue; and a daughter married to Sir *Pierce Power* of *Ireland*, Knt.

[*Richard*, the ſecond ſon, was one of the greateſt men of his age; and as he has left ſome memoirs of himſelf, written in 1632, in the ſixty ſeventh year of his age, which were never yet publiſhed entire, I ſhall inſert ſo valuable a piece here in juſtice to his character and memory.

" *Sir* RICHARD BOYLE, *Knt. earl of* CORKE, *his true Remembrances.*

I Sir *Richard Boyle*, Knt. lord *Boyle*, baron of *Youghall*, viſcount *Dungarvan*, earl of *Corke*, lord high treaſurer of *Ireland*, one of his majeſty's honourable privy council, and one of the two lords juſtices for the government of this kingdom, do commend theſe *true remembrances* to poſterity this 23d day of June, *anno Domini* 1632, having lived in this kingdom of *Ireland* full forty four years, and ſo long after as it ſhall pleaſe almighty God.

MY father, Mr. *Roger Boyle*, was born in *Herefordſhire*. My mother *Joan Naylor*, daughter to *Robert Naylor* of *Canterbury* in the county of *Kent*, Eſq; was born the 15th of *October* in the 21ſt year of king *Henry* VIII. and my ſaid father and mother were married in *Canterbury* the 16th of October in the 8th year of queen *Elizabeth*. My father died at *Preſton* near *Feverſham* in *Kent* the 24th of March 1576. My mother never married again, but lived ten years a widow, and then departed this life at *Feverſham* aforeſaid the 20th of March 1586. And they both are buried in one grave in the upper end of the chancel of the pariſh church of *Preſton*; in memory of which my deceaſed and worthy parents, I, their ſecond ſon, have *in anno Domini* 1629 erected a fair alabaſter tomb over the place, where they were buried, with an iron gate before it for the better preſervation thereof.

SIR *Richard Boyle*, now earl of *Corke*, the ſecond ſon of *Roger Boyle*, Eſq; was born in the city of *Canterbury*, as I find it written by my father's own hand, the 3d of October 1566.

(*a*) Letter of doctor *John Beale* to Mr. *Samuel Hartlib*.

(*b*) Viſitat. Co. Hereford. in Biblioth. Harleyanâ 90. A. 17. P. 72, 73. apud *Collins*'s Peerage of *England*, Vol. II. p. 358. 2d. edit. *London* 1741.

(*c*) *Seager*'s Baron. M. S. in Biblioth. Cotton. apud *Collins*, p. 359.

(*d*) Viſitat. Co. Hereford, *ut antea.*

AFTER the deceaſe of my father and mother, I being the ſecond ſon of a younger brother, having been a ſcholar in *Bennet* college *Cambridge*, and a ſtudent in the *Middle Temple*, *London*, finding my means unable to ſupport me to ſtudy the laws in the inns of court, put myſelf into the ſervice of Sir *Richard Manwood*, Knt. lord chief baron of her majeſty's court of Exchequer, whom I ſerved as one of his clerks; and perceiving, that the employment would not raiſe a fortune, I reſolved to travel into foreign kingdoms, and to gain learning, and knowledge, and experience abroad in the world. And it pleaſed the Almighty by his divine providence to take me, I may ſay juſtly, as it were, by the hand, and lead me into *Ireland*, where I happily arrived at *Dublin* on the Midſummer-Eve, the 23d day of June, 1588. I was married at *Limerick* to Mrs. *Joan Apſley*, one of the two daughters and coheirs of *William Apſley*, Eſq; the 6th of November 1595, who brought me in 500 *l.* lands *per* year, which I ſtill enjoy, it being the beginning and foundation of my fortune; and ſhe died at *Moyallo* the 14th of December 1599, in travel of her firſt child, who was born a dead ſon, and both of them buried together in *Buttavant* church.

WHEN firſt I arrived at *Dublin* in *Ireland*, the 23d of June 1588, all my wealth then was twenty ſeven pounds three ſhillings in money, and two tokens, which my mother had given me, viz. a diamond ring, which I have ever ſince and ſtill do wear, and a bracelet of gold worth about ten pounds; a taffety doublet cut with and upon taffety, a pair of black velvet breeches laced, a new *Milan* fuſtian ſuit laced and cut upon taffety, two cloaks, competent linen and neceſſaries, with my rapier and dagger. And ſince, the bleſſing of God, whoſe heavenly providence guided me hither, hath enriched my weak eſtate in beginning with ſuch a fortune, as I need not envy any of my neighbours, and added no care or burthen of my conſcience thereunto. And the 23d of June 1632, I have ſerved my God, queen *Elizabeth*, king *James*, and king *Charles*, full forty four years, and ſo long after, as it ſhall pleaſe God to enable me.

WHEN God had bleſſed me with a reaſonable fortune and eſtate, Sir *Henry Wallop* of *Wares*, Sir *Robert Gardiner*, chief juſtice of the King's Bench, Sir *Robert Dillam*, chief juſtice of the Common Pleas, and Sir *Richard Bingham*, chief commiſſioner of *Connaught*, being diſpleaſed for ſome purchaſes I had made in the province, they all joined together, by their lies complaining againſt me to queen *Elizabeth*, expreſſing, that I came over a young man, without any eſtate or fortune; and that I had made ſo many purchaſes, as it was not poſſible to do it without ſome foreign prince's purſe to ſupply me with money: that I had acquired divers caſtles and abbeys upon the ſea-ſide fit to receive and entertain Spaniards: that I kept in my abbeys fraternities and convents of friers in their habits, who ſaid maſs continually: and that I was ſuſpected in my religion; with divers other malicious ſuggeſtions, whereof having ſome ſecret notice, I reſolved to go into *Munſter*, and ſo into *England*, to juſtify myſelf. But before I could take ſhipping, the general rebellion in *Munſter* broke out: all my lands were waſted, as I could ſay, that I had not one peny of certain revenue left me, to the unſpeakable danger and hazard of my life. Yet God preſerved me, as I recovered *Dingle*, and got ſhipping there, which tranſported me to *Briſtol*, from whence I travelled to *London*, and betook myſelf to my former chamber in the Middle Temple, intending to renew my ſtudies in the law, till the rebellion were paſt over. Then *Robert* earl of *Eſſex* was deſigned for the government of this kingdom, into whoſe ſervice I was recommended by Mr. *Anthony Bacon*. Whereupon his lordſhip very nobly received me, and uſed me with favour and grace, in employing me in the iſſuing out his patent and commiſſions for the government of *Ireland*; whereof Sir *Henry Wallop*, treaſurer, having notice, and being conſcious in his own heart, that I had ſundry papers and collections of *Michael Kettlewell*'s his late under-treaſurer, which might diſcover a great deal of wrong and abuſe done to the queen in his late accounts; and ſuſpecting, if I were countenanced by the earl of *Eſſex*, that I would bring thoſe things to light, which might much prejudice or ruin his reputation or eſtate, although I vow to God, until I was provoked, I had no thought of it; yet he, utterly to ſuppreſs me, renewed his former complaints againſt me to the queen's majeſty. Whereupon, by her majeſty's ſpecial directions, I was ſuddenly attached and conveyed cloſe priſoner to the Gate-Houſe; all my papers ſeized and ſearched; and although nothing could appear to my prejudice, yet my cloſe reſtraint was continued till the earl of *Eſſex* was gone to *Ireland*, and two months afterwards; at which time, with much ſuit, I obtained the favour of her ſacred majeſty to be preſent at my anſwers, where I ſo fully anſwered and cleared all their objections, and delivered ſuch full and evident juſtifications for my own acquittal, as it pleaſed the queen to uſe theſe words, viz. "By God's death, theſe are "but inventions againſt this young man; and all his ſufferings are for being able to do us "ſervice, and thoſe complaints urged to foreſtal him therein. But we find him to be a man "fit to be employed by ourſelves; and we will employ him in our ſervice; and *Wallop* and "his adherents ſhall know, that it ſhall not be in the power of any of them to wrong him; "neither ſhall *Wallop* be our treaſurer any longer." Thereupon ſhe directed her ſpeech to her lords in her council there preſent, and commanded them preſently to give her the names of ſix men, out of which ſhe might chuſe one to be treaſurer of *Ireland*, her election falling upon Sir *George Carew*, of *Cookington*. And then the queen aroſe from council, and gave orders, not only for my preſent enlargement, but alſo diſcharging all my charges and fees during my reſtraint, and gave me her royal hand to kiſs, which I did heartily, humbly thanking God for that deliverance.

BEING

BEING commanded by her majeſty to attend at court, it was not many days before her highneſs was pleaſed to beſtow upon me the office of clerk of the council of *Munſter*, and to recommend me over to Sir *George Carew*, after earl of *Totneſs*, then lord preſident of *Munſter*. Whereupon I bought of Sir *Walter Ralegh* his ſhip called the *Pilgrim*, into which I took a freight of ammunition and victuals, and came in her myſelf by long ſeas, and arrived at *Carrig-Foyl-Kerry*, where the lord preſident and the army were at the ſiege of that caſtle; which when he had taken, I was there ſworn clerk of the council of *Munſter*, and preſently after made a juſtice and quorum throughout all that province. And this was the ſecond riſe, that God gave to my fortune.

THEN, as clerk of the council, I attended the lord preſident in all his employments, and waited upon him all the whole ſiege of *Kingſale*, and was employed by his lordſhip to her majeſty, with the news of that happy victory; in which employment I made a ſpeedy expedition to the court; for I left my lord preſident at *Shannon* caſtle, near *Corke*, on the Monday morning about two of the clock, and the next day, being Tueſday, I delivered my packet, and ſupped with Sir *Robert Cecil*, being then principal ſecretary of ſtate, at his houſe in the *Strand*; who after ſupper held me in diſcourſe till two of the clock in the morning; and by ſeven that morning called upon me to attend him to the court, where he preſented me to her majeſty in her bed-chamber, who remembered me, calling me by my name, and giving me her hand to kiſs, telling me, that ſhe was glad, that I was the happy man to bring the firſt news of that glorious victory. And after her majeſty had interrogated with me upon ſundry queſtions very punctually, and that therein I had given her full ſatisfaction in every particular, ſhe again gave me her hand to kiſs, and recommended my diſpatch for *Ireland*, and ſo diſmiſſed me with grace and favour.

AT my return into *Ireland*, I found my lord preſident ready to march with the army to the ſiege of *Beer-haven* caſtle, then fortified and poſſeſſed by the *Spaniards* and ſome Iriſh rebels; which after battering we had made aſſaultable, we entered, and put all to the ſword. His lordſhip fell then to reducing thoſe weſtern rebels of the province to ſubjection and obedience of her majeſty's laws; and having placed gariſons and wards in all places of importance, made his return to *Corke*, and in his way homewards acquainted me with his reſolution; it being preſently to employ me into *England*, to obtain licence from her majeſty, for his repair to her royal preſence: at which time he propounded unto me the purchaſe of all Sir *Walter Ralegh*'s lands in *Munſter*, offering me his beſt aſſiſtance for the compaſſing thereof; which he really performed. For, upon my departure for *England*, he wrote by me two effectual letters, one to Sir *Robert Cecil*, wherein he was pleaſed to magnify my ſervice and abilities; and concluding with a requeſt, that he would make interceſſion with Sir *Walter Ralegh* to ſell me all his lands in *Ireland*, that were then altogether waſte and deſolate. To Sir *Walter Ralegh* he alſo wrote, adviſing him to ſell me all his lands in *Ireland*, then untenanted, and of no value to him; mentioning withal, that, in his lordſhip's knowledge, his eſtate in *Ireland* never yielded him any benefit, but contrariwiſe ſtood him in two hundred pounds yearly for the maintenance and ſupport of his titles. Whereupon there was a meeting between Sir *Robert Cecil*, Sir *Walter Ralegh*, and myſelf; where Sir *Robert Cecil* mediated and concluded the purchaſe between us. Accordingly my aſſurances were perfected; and this was a third addition and riſe to my eſtate.

THEN I returned into *Ireland* with my lord preſident's licence to repair to court, where in his way to *Dublin* (where he propoſed to embark) he dealt very nobly and father-like by me, in perſuading me, it was high time for me to take a wife, in hopes of poſterity to inherit my lands; adviſing me to make choice of Sir *Geoffry Fenton*'s daughter; and that if I could affect her, he would treat with her parents to have the match between us; wherein he prevailed ſo far, as the 9th of March 1602, I was, in his lordſhip's preſence, contracted to her in her father's houſe at *Dublin* *.

* Dr. *Anthony Walker*. in p. 45, 46, of his funeral ſermon on *Mary*, counteſs dowager of *Warwick*, daughter to the earl of *Corke*, relates a very remarkable ſtory, concerning this marriage, which he had from that lady's own mouth, and is as follows: "Mr. *Boyle*, after earl of *Corke*, who was then a widower, came one morning "to wait upon Sir *Geoffry Fenton*, at that time a great officer of ſtate in the kingdom of *Ireland*; who being engaged in buſineſs, and not knowing who it was, who deſired to ſpeak with him, a while delayed him acceſs, "which time he ſpent pleaſantly with his young daughter in her nurſe's arms. But when Sir *Geoffry* came and ſaw "whom he had made ſtay ſomewhat long, he civilly excuſed it. But Mr. *Boyle* replied, he had been very well "entertained, and ſpent his time much to his ſatisfaction in courting his daughter, if he might obtain the honour "to be accepted for his ſon-in-law. At which Sir *Geoffry* ſmiling, to hear one, who had been formerly married, "move for a wife carried in arms, and under two years old, aſked him, if he would ſtay for her? To which he "frankly anſwered him, he would; and Sir *Geoffry* as generouſly promiſed him, he ſhould then have his full conſent. And they both kept their words honourably; and by this virtuous lady he had thirteen children." Mr. *Evelyn*, in a letter to Dr. *William Wotton*, dated at *Wotton* in *Surrey*, Sept. 10th 1703, mentions likewiſe this ſtory in the following terms; "that Mr. *Boyle* coming to adviſe with Sir *Geoffry Fenton*, now knighted, finding "him engaged with another client, and ſeeing a pretty child in the nurſe's arms, entertained himſelf with them, "till Sir *Geoffry* came to him, making his excuſe for cauſing him to wait ſo long. Mr. *Boyle* pleaſantly told him, "he had been courting a young lady for his wife. And ſo it fortuned, that ſixteen years after, Mr. *Boyle* made "his addreſſes in good earneſt, and married the young lady." Both theſe accounts are attended with great difficulties, eſpecially that of Dr. *Walker*, which is abſolutely irreconcilable with the earl of *Corke*'s own narrative, from which it appears, that his firſt lady died on the 14th of December 1599, and that he married his ſecond, Sir *Geoffry Fenton*'s daughter, on the 25th of July, 1603; ſo that it is impoſſible, that while he was *a widower*, he ſhould enter into any engagements for the latter, while ſhe was *in her nurſe's arms*, and *under two years old*, ſince there was only an interval of three years and eight months between the death of his firſt wife and his marriage with the ſecond.

THE 25th of July, 1603, I was married to my second wife, Mrs. *Catharine Fenton*, the only daughter of Sir *Geoffry Fenton*, principal secretary of state, and privy counsellor in *Ireland*, with whom I never demanded any marriage portion, neither promise of any, it not being in my consideration; yet her father, after my marriage, gave me one thousand pounds in gold with her. But that gift of his daughter unto me I must ever thankfully acknowledge as the crown of all my blessings; for she was a most religious, virtuous, loving, and obedient wife unto me all the days of her life, and the happy mother of all my hopeful children, whom with their posterity I beseech God to bless.

THE 10th of July, 1620, my eldest brother, Dr. *John Boyle*, lord bishop of *Corke* and *Ross*, departed this life at *Bishop's-Court* near *Corke*; and on the 12th of that month was buried in my new tomb, erected in the chapel, which I re-edified at *Youghall*. After whose death I obtained those bishoprics from his majesty for my uncle *Michael Boyle*'s son, *Richard Boyle*, for whom I formerly obtained the deanery of *Waterford*, who now succeeds my brother in those bishoprics.

I *Richard*, earl of *Corke*, was knighted by Sir *George Carew*, lord deputy of *Ireland*, at St. *Mary*'s abbey, near *Dublin*, the 25th of July 1603, being St. *James*'s day, and the very day, that I was married to my second wife, Mrs. *Catharine Fenton*. I was sworn a privy counsellor to King *James* for the province of *Munster* at the council table at *Dublin* by the lord *Chichester*, then lord deputy of *Ireland*, the 12th of March, 1606, with commandment from the lord deputy and council to *Henry Dunkard*, then lord president of *Munster*, to admit me into that council; who, upon former direction from this state, had refused either to swear or admit me a counsellor of that province.

I WAS sworn a privy counsellor of state of the kingdom of *Ireland* by the lord *Chichester*, then lord deputy, at *Chichester* house, the 15th of February being the day that I arrived out of *England* at *Dublin*, 1612.

I WAS created lord *Boyle*, baron of *Youghall*, on Michelmas day, the 29th of Sept. 1616.

I WAS created lord viscount of *Dungarvan* and earl of *Corke*, the 26th of October, 1620.

Adam lord *Loftus* of *Ely*, and lord chancellor of *Ireland*, and I, *Richard*, earl of *Corke*, were sworn lords justices for the joint government of this kingdom of *Ireland*, the 26th of October, 1629, with the entertainment of one hundred pounds sterling per month to each of us.

I WAS made lord high treasurer of *Ireland*, and sworn the 9th of November, 1631.

The several days of the births of all the children, that God hath blessed me withall, with the places where they were born, and the names of their godfathers and godmothers.

1. MY first son *Roger*, born at *Youghall* the 1st of August 1606. Sir *Allen Apsley*, Sir *Thomas Brown* godfathers, and lady *Alice Fenton* godmother. He died at *Deptford* in *Kent*, the 10th of October 1615, and was buried there *.

(e) Married to the earl of *Barrimore*.

2. MY first daughter, *Alice Boyle* (e), born at *Youghall*, the 20th of March, 1607; Sir *Robert Tynt* godfather, lady *Fenton* and Mrs. *Bernard* godmothers.

3. MY second daughter, *Sarah Boyle*, born at *Dublin*, the 29th of March, 1609; Sir *William Usher* godfather, lady *Winch* and lady *Ely* godmothers. She was married to Sir *Thomas Moore* first, and then to lord *Robert Digby*, the 15th of December, 1626.

(f) Married to the lord *Goring*.

4. MY third daughter, *Lettice* (f), born the 25th of April, 1610; earl of *Thomond* godfather, lady *Chichester* and lady *Moore* godmothers.

5. MY fourth daughter, *Joan*, born the 14th of June, 1611; Sir *William Fenton* godfather, and —— *Brown* and lady *Fenton* godmothers. She was married to the earl of *Kildare*, Aug. 15, 1628, and had two children, *Richard* and *Elizabeth*.

6. MY second son, *Richard*, was born at the college of *Youghall*, the 20th of October, 1612; earl of *Thomond*, Sir *Richard Aldworth*, and Mr. *Thomas Ball* of *London*, godfathers, and lady *Ann Parsons* godmother. God grant he may serve and fear him religiously, and be a faithful subject and servant to the king's majesty and his heirs, and live many years full of good works and of virtuous children, and be a worthy pillar and patriot in this kingdom. He being viscount of *Dungarvan*, was knighted in my house in *Youghall* the 13th of Aug. 1624, by the lord *Falkland*, lord deputy general of *Ireland*; and my said son departed *Dublin*, to begin his travels into foreign kingdoms, the 4th of June, 1632, I allowing him one thousand pounds a year in his travels.

(g) Married to the lord viscount *Ranelagh*.

7. MY daughter *Catharine* (g), born the 22d of March, 1614; Sir *Robert Bolton* godfather, lady *Fenton* and lady *Harris* godmothers.

8. MY son *Jeoffry* born at *Youghall* the 10th of April, 1616. He died.

9. MY daughter *Dorothy* born the 31st of December, 1617. She was married to lord *Loftus*.

10. MY son *Lewis* born the 23d of May, 1619, and in the year 1628 he was created baron of *Bandonbridge*, and lord viscount *Boyle* of *Kenelmeaky*.

(b) Doctor *George Stanhope*'s letter to *John Evelyn*, Esq; dated Sept. 6, 1703, and Mr. *Evelyn*'s letter to Dr. *W. Wotton*, dated at *Wotton* in *Surrey*, Sept. 10, 1703.

* He died at *Say*'s-*Court* in that town, and was interred in the parish church, where a monument was erected to him with the following inscription (b):

H. S. E. *ROGERUS BOYLE, Richardi Comitis Corcaciensis Filius primogenitus; qui in Hiberniâ natus, in Cantio solo patris natali denatus, dum hic ingenii cultum capessit, puer eximiæ indolis præcacitatem ingenii funere luit immaturo. Sic luculenti, sed terreni patrimonii factus exhæres, cœlestem erevit hæreditatem. Decessit Anno* CIↃDCXV. VI. *Eid.* VIII*bris.*

11. My ſon *Roger* born the 25th of April 1621. He was created lord *Boyle*, baron of *Broghill*, 1628.

12. My ſon *Francis* (*i*) born the 25th of June 1623.

13. My daughter *Mary* (*k*) born the 11th of November 1624.

14. My ſeventh ſon *Robert* born the 25th of January 1626.

15. My eighth and laſt daughter *Margaret* (*l*), born in *Channel-Row* in *Weſtminſter* the 30th of April 1629.

(*i*) Afterwards lord *Shannon*.
(*k*) Married to the earl of *Warwick*.
(*l*) She died unmarried.

THE great God of heaven I do humbly and heartily beſeech, to bleſs all theſe my children, whom he hath in his mercy ſo graciouſly beſtowed upon me, with long and religious lives, and that they may be fruitful in virtuous children and good works, and continue till their lives end loyal and dutiful ſubjects to the king's majeſty and his heirs, and approve themſelves good patriots and members to his commonwealth; which is the prayer and charge of me their father in the 67th year of my age, 1632.

My dear wife, the crown of all my happineſs, and mother of all my children, *Catharine* counteſs of *Corke*, was tranſlated at *Dublin* from this life into a better the 16th of February 1629-30, and was the 17th privately buried in the night in the upper end of the choir of St. *Patrick*'s church in *Dublin*, in the grave or vault, wherein Dr. *Weſton*, her grandfather, and good lord chancellor of *Ireland*, and Sir *Geoffry Fenton*, his majeſty's principal ſecretary of ſtate for this realm, were entomb'd. Her funerals were honourably ſolemnized in publick the 11th of March *anno Domini* 1629. In the perpetual memory of which my virtuous and religious deceaſed wife, and of her predeceſſors and poſterity, I have cauſed a very fair tomb to be erected, with a cave or cellar of hewed ſtone underneath it.

I HAVE purchaſed from the dean and chapter of St. *Patrick*'s church the inheritance of that upper part of the chancel, wherein the cave or cellar under ground is made, and wherein the tomb is built, to be a burying place for me and my poſterity, and their children."

THIS noble earl continued in great proſperity till the breaking out of the rebellion in *Ireland* in 1641; and the county of *Corke* was the laſt, that ſuffered under the violences of the Papiſts, being the beſt inhabited with Engliſh of any part of that kingdom, by the plantations made by his lordſhip, and was in a great meaſure preſerved by his generoſity and diligence. He was then juſt returned out of *England*, and on this irruption immediately raiſed two troops of horſe, which he put under the command of his ſons, the lord viſcount *Kinelmeaky* and the lord *Broghill*, maintaining them and 400 foot for ſome months at his own charge (*m*); and at the battle of *Liſcarrol*, on the 3d of September 1642, wherein the Engliſh obtained a compleat victory, had no leſs than four of his ſons engaged, viz. his eldeſt ſon the lord viſcount *Dungarvan*, the lord viſcount *Kinelmeaky*, the lord *Broghill*, and Mr. *Francis Boyle*, afterwards created lord viſcount *Shannon*. But in this engagement he had the misfortune of loſing one of his ſons, the lord *Kinelmeaky*, governor of *Bandon*, who in ſeveral encounters had defeated the rebels, and with his father and brothers preſerved the county of *Corke* (*n*). At length this great man, in the midſt of theſe confuſions, departed this life at *Youghall*, and was interred there near the date (if not on the day) of the ceſſation of arms concluded at *Sigginſtown*, Sept. 15, 1643 (*o*), *unwilling to ſurvive what he ſuſpected might not be ſuſpicious to the Engliſh, or conducible to the end, for which it was deſigned; wherein he propheſied not ill* (*p*). Mr. *Borlaſe* tells us (*q*), that his lordſhip "was a perſon, for his abilities and knowledge in the affairs of the world, eminently obſervable, inaſmuch, as though he was no peer of *England*, he was admitted to ſit in the lords houſe upon the wool-ſacks, *ut conſiliarius*. And for all the eſtate he arrived at, (which was the greateſt in the memory of the laſt age) none ever taxed him with exorbitances, but ſuch as thought princes had too little, and religious men not enough." Another writer (*r*) likewiſe gives him this character, that he was one of the moſt extraordinary perſons, either that or any other age hath produced, with reſpect to the great and juſt acquiſitions of eſtate, that he made, and the publick works, that he began and finiſhed, for the advancement of the Engliſh intereſt and the proteſtant religion in *Ireland*; as churches, alms-houſes, free-ſchools, bridges, caſtles, and towns, *viz. Liſmore*, *Tallow*, *Cloghmakilty*, *Iniſkeen*, *Caſtletown*, and *Bandon*, (which laſt place coſt him 14000 *l.*) inſomuch that when *Cromwell* ſaw theſe prodigious improvements, which he little expected to find in *Ireland*, he declared, that *if there had been an earl of* Corke *in every province, it would have been impoſſible for the Iriſh to have raiſed a rebellion.* And whilſt he was carrying on theſe ſolid works, he lived in his family at a rate of plenty, that exceeded thoſe, who conſumed great eſtates in the laviſh ways of ill-ordered exceſs. His motto, *God's providence is my inheritance*, ſhews, from whence he derived all his bleſſings; the greateſt of which was the numerous and noble poſterity he had to leave his eſtate unto."

(*m*) *Cox*'s Hiſtory of *Ireland*, Vol. II. p. 95.
(*n*) Ibid. p. 112.
(*o*) *Borlaſe*, Reduction of *Ireland*, p. 209.
(*p*) Id. ibid.
(*q*) Ibid.
(*r*) *Cox*, Introduction to the 2d volume of his Hiſtory of *Ireland*.

ROBERT BOYLE, Eſq; his ſeventh and yonngeſt ſon, and one of the greateſt ornaments of this noble family, as well as the age and country, in which he lived, has left us ſome memoirs of the younger part of his life, drawn up ſoon after his return from his travels, which the reader will undoubtedly chooſe to read in his own words.

An Account of *PHILARETUS*, [i. e. Mr. *R. BOYLE*,] during his Minority.

NOT needleſsly to confound the herald with the hiſtorian, and begin a relation by a pedigree, I ſhall content myſelf to inform you, that the immediate parents of our *Philaretus* were, of the female ſex, [*Catharine*, daughter of Sir *Geoffry Fenton*] a woman, that wanted not beauty, and was rich in virtue, and on the father's ſide, that *Richard Boyle*, earl of *Corke*, who, by God's bleſſing on his proſperous induſtry, from very inconſiderable beginnings, built ſo plentiful and ſo eminent a fortune, that his proſperity has found many admirers, but few parallels.

HE was born the 14th child of his father (of which five women, and four men, do yet ſurvive) in the year 1626-7, upon St. *Paul*'s converſion day, at a country-houſe of his father's, called *Liſmore*, then one of the nobleſt ſeats and greateſt ornaments of the province of *Munſter*, in which it ſtood; but now ſo ruined by the ſad fate of war, that it ſerves only for an inſtance and a lecture of the inſtability of that happineſs, that is built upon the uncertain poſſeſſion of ſuch fleeting goods, as itſelf was.

To be ſuch parents ſon, and not their eldeſt, was a happineſs, that our *Philaretus* would mention with great expreſſions of gratitude; his birth ſo ſuiting his inclinations, and deſigns, that, had he been permitted an election, his choice would ſcarce have altered God's aſſignment. For as on the one ſide, a lower birth would have too much expoſed him to the inconveniences of a mean deſcent, which are too notorious to need ſpecifying; ſo on the other ſide, to a perſon, whoſe humour indiſpoſes him to the diſtracting hurry of the world, the being born heir to a great family is but a glittering kind of ſlavery, whilſt obliging him to a public entangled courſe of life, to ſupport the credit of his family, and tying him from ſatisfying his deareſt inclinations, it often forces him to build the advantages of his houſe upon the ruins of his own contentment.

A MAN of mean extraction is ſeldom admitted to the privacy and ſecrets of great ones promiſcuouſly, and ſcarce dares pretend to it, for fear of being cenſured ſaucy, or an intruder; and titular greatneſs is ever an impediment to the knowledge of many retired truths, that cannot be attained without familiarity with meaner perſons, and ſuch other condeſcentions, as fond opinion, in great men, diſapproves and makes diſgraceful.

BUT now our *Philaretus* was born in a condition, that neither was high enough to prove a temptation to lazineſs, nor low enough to diſcourage him from aſpiring. And certainly to a perſon, that affected ſo much an univerſal knowledge, and arbitrary viciſſitudes of quiet and employments, it could not be unwelcome to be of a quality, that was a handſom ſtirrup to preferment, without an obligation to court it, and which might at once both protect his higher pretenſions from the guilt of ambition, and ſecure his retiredneſs from contempt.

WHEN once *Philaretus* was able, without danger, to ſupport the incommodities of a remove, his father, who had a perfect averſion for their fondneſs, who uſe to breed their children ſo nice and tenderly, that a hot ſun, or a good ſhower of rain, as much endangers them, as if they were made of butter, or of ſugar, ſends him away from home, and commits him to the care of a country nurſe, who by early inuring him, by ſlow degrees, to a coarſe but cleanly diet, and to the uſual paſſions of the air, gave him ſo vigorous a complexion, that both hardſhips were made eaſy to him by cuſtom, and the delights of conveniences and eaſe were endeared to him by their rarity.

SOME few years after this, two great diſaſters befel *Philaretus*; the one was the deceaſe of his mother, whoſe death would queſtionleſs have exceſſively afflicted him, had but his age permitted him to know the value of his loſs; for he would ever reckon it amongſt the chief misfortunes of his life, that he did never know her, that gave it him, her free and noble ſpirit (which had a handſom manſion to reſide him) added to her kindneſs and ſweet carriage to her own, making her ſo hugely regretted by her children, and ſo lamented by her huſband, that not only he annually dedicated the day of her death to ſolemn mourning for it, but burying in her grave all thoughts of after marriage, he rejected all motions of any other match, continuing a conſtant widower till his death.

THE ſecond misfortune, that befel *Philaretus*, was his acquaintance with ſome children of his own age, whoſe ſtuttering habitude he ſo long counterfeited, that at laſt he contracted it; poſſibly a juſt judgment upon his deriſion, and turning the effects of God's anger into the ſubject matter of his ſport. Divers experiments, believed the probableſt means of cure, were tried with as much ſucceſsleſſneſs as diligence; ſo contagious and catching are men's faults, and ſo dangerous is the familiar commerce of thoſe condemnable cuſtoms, that being imitated but in jeſt, come to be learned and acquired in earneſt.

BUT to ſhow, that theſe afflictions made him not leſs the object of heaven's care, he much about this time eſcaped a danger, from which he owed his deliverance wholly to providence, being ſo far from contributing to it himſelf, that he did his endeavour to oppoſe it: for waiting on his father up to *Dublin*, there to expect the return of his eldeſt brother (then

ſanded out of *England*, with his new wife, the earl of *Cumberland*'s heir) as they were to paſs over a brook, at that time ſuddenly by immoderate ſhowers ſwelled to a torrent, he was left alone in a coach, only with a foot-boy, where a gentleman of his father's very well horſed accidentally eſpying him, in ſpite of ſome others and his own unwillingneſs and reſiſtance, (they not believing his ſtay dangerous) carried him in arms over the rapid water, which proved ſo much beyond expectation both ſwift and deep, that horſes with their riders were violently hurried down the ſtream, which eaſily overturned the unloaded coach, the horſes (after by long ſtruggling they had broke their harneſs) with much ado ſaving themſelves by ſwimming.

As ſoon as his age made him capable of admitting inſtruction, his father by a Frenchman, and by one of his chaplains, had him taught both to write a fair hand, and to ſpeak French and Latin, in which, eſpecially the firſt, he proved no ill proficient, adding to a reaſonable forwardneſs in ſtudy a more than uſual inclination to it.

THIS ſtudiouſneſs obſerved in *Philaretus* endeared him very much unto his father, who uſed highly to commend him both for it and his veracity, of which latter he would often give him this teſtimony, that he never found him in a lie in all his life-time. And indeed lying was a vice both ſo contrary to his nature, and ſo inconſiſtent with his principles, that as there was ſcarce any thing he more greedily deſired than to know the truth, ſo was there ſcarce any thing he more perfectly deteſted, than not to ſpeak it: which brings into my mind a fooliſh ſtory I have heard him jeered with by his ſiſter my lady *Ranelagh*, how ſhe having given ſtrict order to have a fruit-tree preſerved for his ſiſter-in-law, the lady *Dungarvan*, then big with child, he accidentally coming into the garden, and ignoring the prohibition, did eat half a ſcore of them, for which being chidden by his ſiſter *Ranelagh*, (for he was yet a child) and being told by way of aggravation, that he had eaten half a dozen plumbs, Nay truly, ſiſter, (anſwers he ſimply to her) I have eaten half a ſcore. So perfect an enemy was he to a lie, that he had rather accuſe himſelf of another fault, than be ſuſpected to be guilty of that. This trivial paſſage I have mentioned now, not that I think, that in itſelf it deſerves a relation, but becauſe as the ſun is ſeen beſt at his riſing and his ſetting, ſo men's native diſpoſitions are clearlieſt perceived, whilſt they are children, and when they are dying. And certainly theſe little ſudden accidents are the greateſt diſcoverers of mens true humours; for whilſt the inconſiderateneſs of the thing affords no temptation to diſſemble, and the ſuddenneſs of the time allows no leiſure to put diſguiſes on, men's diſpoſitions do appear in their true genuine ſhape, whereas moſt of thoſe actions, that are done before others, are ſo much done for others; I mean moſt ſolemn actions are ſo perſonated, that we may much more probably gueſs from thence, what men deſire to ſeem, than what they are; ſuch publick formal acts much rather being adjuſted to men's deſigns, than flowing from their inclinations.

Philaretus had now attained, and ſomewhat paſt the eighth year of his age, when his father (who ſupplied what he wanted in ſcholarſhip himſelf, by being both a paſſionate affecter, and eminent patron of it) ambitious to improve his early ſtudiouſneſs, and conſidering, that great men's children breeding up at home tempts them to nicety, to pride, and idleneſs, and contributes much more to give them a good opinion of themſelves, than to make them deſerve it, reſolves to ſend over *Philaretus* in the company of Mr. *F. B.* his elder brother, to be bred up at *Eton* college near *Windſor*, whoſe provoſt at that time was Sir *Henry Wotton*, a perſon, that was not only a fine gentleman himſelf, but very well ſkilled in the art of making others ſo, betwixt whom and the earl of *Corke* an ancient friendſhip had been conſtantly cultivated by reciprocal civilities. To him therefore the good old earl recommends *Philaretus*, who having laid a week at *Youghall* for a wind, when he firſt put to ſea, was by a ſtorm beaten back again, not only a taſte, but an omen of his future fortune. But after eight days further ſtay, upon the ſecond ſummons of a promiſing gale, they went aboard once more, and (though the Iriſh coaſts were then ſufficiently infeſted with Turkiſh gallies) having by the way touched at *Ilford-combe*, and *Minehead*, at laſt they happily arrived at *Briſtol*.

Philaretus, in the company of his brother, after a ſhort ſtay to repoſe and refreſh themſelves at *Briſtol*, ſhaped his journey directly for *Eton* college, where a gentleman of his father's, ſent to convey them thither, departing, recommended him to the eſpecial care of Sir *Henry Wotton*, and left with him, partly to inſtruct, and partly to attend him, one *R. C.* one that wanted neither vices, nor cunning to diſſemble them; for though his primitive fault was only a dotage upon play, yet the exceſſive love of that goes ſeldom unattended with a train of criminal retainers; for fondneſs of gaming is the ſeducingeſt lure to ill company, and that the ſubtleſt pander to the worſt exceſſes. Wherefore our *Philaretus* deſervedly reckoned it, both amongſt the greateſt and the unlikelieſt deliverances he owed providence, that he was protected from the contagion of ſuch precedents; for though the man wanted not a competency of parts, yet perverted abilities make men but like thoſe wandring fires, philoſophers call *ignes fatui*, whoſe light ſerves not to direct, but to ſeduce the credulous traveller, and allure him to follow them in their deviations. And it is very true, that during the minority of judgment, imitation is the regent in the ſoul, and thoſe, that are leaſt capable of reaſon, are moſt ſwayed by example. A blind man will ſuffer himſelf to be led, though by a dog, or a child.

NOT long our *Philaretus* ſtaid at ſchool, ere his maſter, Mr. *Harriſon*, taking notice of ſome aptneſs, and much willingneſs, in him to learn, reſolved to improve them both by all the gentleſt ways of encouragement; for he would often diſpenſe from his attendance at ſchool, at the accuſtomed hours, to inſtruct him privately and familiarly in his chamber. He would often as it were cloy him with fruit and ſweetmeats, and thoſe little dainties, that age is greedy of, that by preventing the want, he might leſſen both his value and deſire of them. He would ſometimes give him unaſked play-days, and oft beſtow upon him ſuch balls, and tops, and other implements of idleneſs, as he had taken away from others, that had unduly uſed them. He would ſometimes commend others before him, to rouſe his emulation, and oftentimes give him commendations before others, to engage his endeavours to deſerve them. Not to be tedious, he was careful to inſtruct him in ſuch an affable, kind, and gentle way, that he eaſily prevailed with him to conſider ſtudying, not ſo much as a duty of obedience to his ſuperiors, but as the way to purchaſe for himſelf a moſt delightſom and invaluable good. In effect, he ſoon created in *Philaretus* ſo ſtrong a paſſion to acquire knowledge, that what time he could ſpare from a ſcholar's taſk, which his retentive memory made him not find uneaſy, he would uſually employ ſo greedily in reading, that his maſter would ſometimes be neceſſitated to force him out to play, on which, and upon ſtudy, he looked, as if their natures were inverted. But that, which he related to be the firſt occaſion, that made him ſo paſſionate a friend to reading, was, the accidental peruſal of *Quintus Curtius*, which firſt made him in love with other than pedantick books, and conjured up in him that unſatiſfied appetite of knowledge, that is yet as greedy, as when it firſt was raiſed. In gratitude to this book, I have heard him hyperbolically ſay, that not only he owed more to *Quintus Curtius*, than *Alexander* did; but derived more advantage from the hiſtory of that great monarch's conqueſts, than ever he did from the conqueſts themſelves.

WHILST our youth was thus buſied about his ſtudies, there happened to him an accident, that ſilence muſt not cover: for being one night gone to bed, ſomewhat early, whilſt his brother was converſing with ſome company by the fire-ſide, without giving them the leaſt warning or ſummons to take heed, a great part of the wall of their chamber, with the bed, chairs, books, and furniture of the next chamber over it, fell down, at unawares, upon their heads. His brother had his band torn about his neck, and his coat upon his back, and his chair cruſhed and broken under him; but by a luſty youth, then accidentally in the room, was ſnatched from out the ruins, by which *Philaretus* had, in all probability, been immediately oppreſſed, had not his bed been curtained by a watchful providence, which kept all heavy things from falling on it; but the duſt the crumbled rubbiſh raiſed was ſo thick, that he might there have been ſtifled, had not he remembred to wrap his head in the ſheet, which ſerved him as a ſtrainer, through which none but the purer air could find a paſſage. So ſudden a danger, and haſty an eſcape, *Philaretus* would ſometimes mention, with expreſſions both of gratitude and wonder. To which he would add the relation of divers other almoſt contemporary deliverances: of theſe, one was, that, being fallen from his horſe, the beaſt ran over him, and trod ſo near his throat, as within leſs than two inches of it to make a hole in his band, which he long after reſerved for a remembrancer. Another was, that riding through a town, upon a nag of his own, whoſe ſtarting quality he never obſerved before, his horſe, upon a ſudden fright, roſe bolt upright upon his hinder feet, and falling rudely backward with all his weight againſt a wall, had infallibly cruſhed his rider into pieces, if, by a ſtrange inſtinct, he had not caſt himſelf off at firſt, and was quit of it for a ſlight bruiſe. The laſt was, *Philaretus* being newly recovered of a flux, the doctor had preſcribed him a refreſhing *drink*: the fellow, that ſhould adminiſter it, inſtead of it, brings him a very ſtrong *vomit*, prepared and intended for another. *Philaretus* was that morning viſited by ſome of his ſchool-fellows, who (as he was not ill beloved amongſt them) preſented him with ſome ſweet-meats, which having eaten, when afterwards he would have eaten his breakfaſt, his ſtomach, whether out of ſqueamiſhneſs, or divination, forced him to render it again. To which lucky accident the phyſician aſcribed his eſcape from the apothecary's error; for in the abſence of thoſe, that tended him, his phyſick caſt him into hideous torments, the true cauſe of which he never dreamed of, and remained long unconjectured, until the effects betrayed it; for after a long ſtruggling, at laſt the drink wrought with ſuch violence, that they feared, that his life would be diſgorged together with his potion. This accident made him long after apprehend more from the phyſicians, than the diſeaſe, and was poſſibly the occaſion, that made him afterwards ſo inquiſitively apply himſelf to the ſtudy of phyſick, that he might have the leſs need of them, that profeſs it. But *Philaretus* would not aſcribe any of theſe reſcues unto chance, but would be ſtill induſtrious to perceive the hand of heaven in all theſe accidents; and indeed he would profeſs, that in the paſſages of his life, he had obſerved ſo gracious and ſo peculiar a conduct of providence, that he ſhould be equally blind and ungrateful, ſhould he not both diſcern and acknowledge it.

Philaretus having now for ſome two years been a conſtant reſident at *Eton* (if you except a few viſits, which, during the long vacations, he made his ſiſter my lady *Goring* at *Lewes* in *Suſſex*) when about *Eaſter* he was ſent for up to *London* to ſee his eldeſt brother the lord *Dungarvan*, where being viſited with a tertian ague, after the queen's and others doctors remedies had been ſucceſsleſsly aſſayed, at laſt he returned again to *Eton* to derive that health from a good air and diet, which phyſic could not give him. Here to divert his melancholy, they

made

made him read the ſtate adventures of *Amadis de Gaule*, and other fabulous and wandring ſtories, which much more prejudiced him, by unſettling his thoughts, than they could have advantaged him, had they affected his recovery; for meeting in him with a reſtleſs fancy, then made more ſuſceptible of any impreſſions by an unemployed penſiveneſs, they accuſtomed his thoughts to ſuch a habitude of roving, that he has ſcarce ever been their quiet maſter ſince, but they would take all occaſions to ſteal away, and go a-gadding to objects then unſeaſonable and impertinent; ſo great an unhappineſs it is for perſons, that are born with ſuch buſy thoughts, not to have congruent objects propoſed to them at firſt. It is true, that long time after *Philaretus* did in a conſiderable meaſure fix his volatile fancy, and reclaim his thoughts, by the uſe of all thoſe expedients he thought likelieſt to fetter, or at leaſt to curb the roving wildneſs of his wandring thoughts. Amongſt all which the moſt effectual way he found to be the extraction of the ſquare and cube roots, and eſpecially thoſe more laborious operations of algebra, which both accuſtom and neceſſitate the mind to attention, by ſo entirely exacting the whole man, that the ſmalleſt diſtraction, or heedleſſneſs, conſtrains us to renew our trouble, and rebegin the operation. Six weeks had *Philaretus* been troubled with his ague, when he was freed from it by an accident, which is no ſlender inſtance of the force of imagination; for the phyſician having ſent him a purge, to give (as he ſaid) the fatal blow to the diſeaſe, our *Philaretus* had ſo perfect an averſion to all phyſic, and had newly aſſayed it ſo unſucceſsfully, that his complaints induced the maid ſervants of the houſe he lodged in (partly out of complaiſance to him, and partly out of a belief, that phyſic did but exaſperate his diſeaſe) unknown to him, to pour out the portion, and fill the vial with ſyrup of ſtewed prunes, a liquor ſo reſembling it, that *Philaretus* (ſee the force of fancy!) ſwallowed it with the ſame reluctancy, and found the taſte as loathſome as if it had been the purge; but being after acquainted with the couſenage, whether it was, that his ſickneſs (as having already reached its period) would have expired of itſelf, or that his mirth diſpatched it, I pretend not to determine; but certain it is, that from that hour to this, agues and he have ſtill been perfect ſtrangers, and he had much ado to refrain from laughter, when going to thank and reward the doctor for his recovery, he found it wholly aſcribed to the efficacy of the portion he had never ſwallowed, but in imagination.

HE had now ſerved well near half an apprenticeſhip at ſchool, when there arrived intelligence of his father's being landed in *England*, and gone to *Stalbridge*, a place in *Dorſetſhire* then newly purchaſed by him. Thither *Philaretus* accompanies his ſiſter the counteſs of *Kildare* to wait upon him. The good old earl welcomed him very kindly, for whether it were to the cuſtom of old people (as *Jacob* doted moſt on *Benjamin* and *Joſeph*) to give their eldeſt children the largeſt proportions of their fortunes, but the youngeſt the greateſt ſhare of their affections; to a likeneſs obſerved in *Philaretus*, both to his father's body and his mind; or, as it ſeems moſt likely, to his never having lived with his father to an age, that might much tempt him to run in debt, and take ſuch other courſes to provoke his diſlike, as in his elder children he ſeverely diſreliſhed; to which if theſe cauſes the effect is to be aſcribed, it is not my taſk to reſolve, but certain it is, that from *Philaretus*'s birth, untill his father's death, he ever continued very much his favourite. But after ſome weeks enjoyment of the ſummer diverſions at *Stalbridge*, when his father removed to *London*, he left him by the way at *Eton* college, from whence at his return in the Weſt, ſome few months after, he took him abſolutely away, after *Philaretus* had ſpent in that ſchool (then very much thronged with young nobility) not much beneath four years, in the laſt of which he forgot much of that *Latin* he had got, for he was ſo addicted to more ſolid parts of knowledge, that he hated the ſtudy of bare words naturally, as ſomething, that reliſhed too much of pedantry to conſort with his diſpoſition and deſigns; ſo that by the change of his old courteous ſchoolmaſter for a new rigid fellow, loſing thoſe encouragements, that had formerly ſubdued his averſion to verbal ſtudies, he quickly quitted his Terence and his grammar, to read in hiſtory their gallant acts, that were the glory of their own, and the wonder of our times. And indeed it is a much nobler ambition to learn to do things, that may deſerve a room in hiſtory, than only to learn, how congruouſly to write ſuch actions in the gown-men's language.

As ſoon as *Philaretus* was arrived at *Stalbridge*, his father aſſigned the care of teaching him to one Mr. *W. Douch*, then parſon of that place, and one of his chaplains; and, to avoid the temptations to idleneſs, that home might afford, made him both lodge and diet where he was taught, though it were not diſtant from his father's houſe above twice a muſket-ſhot. This old divine inſtructing our youth both with care and civility, ſoon brought him to renew his firſt acquaintance with the Roman tongue, and to improve it ſo far, that in that language he could readily enough expreſs himſelf in proſe, and began to be no dull proficient in the poetic ſtrain; which latter he was naturally addicted to, reſenting a great deal of delight in the converſation of the Muſes, which nevertheleſs he ever ſince that time forbore to cultivate; not out of any diſlike or undervaluing of poetry, but becauſe in his travels having by diſcontinuance forgot much of the Latin tongue, he afterwards never could find time to redeem his loſſes by a ſerious ſtudy of the ancient poets. And then for Engliſh verſes, he ſaid, they could not be certain of a laſting applauſe, the changes of our language being ſo great and ſudden, that the rareſt poems within few years will paſs for obſolete; and therefore he uſed to liken the writers in Engliſh verſe to ladies, that have their pictures drawn with the

clothes now worn, which, though at preſent never ſo rich, and never ſo much in faſhion, within a few years hence will make them look like anticks. Yet did he at idle hours write ſome few verſes, both in French and Latin, and many copies of amorous, merry, and devout ones in Engliſh; moſt of which, uncommunicated, the day he came of age, he ſacrificed to Vulcan, with a deſign to make the reſt periſh by the ſame fate, when they came within his power, though amongſt them were many ſerious copies, and one long one, amongſt the reſt, againſt wit profanely or wantonly employed; thoſe two vices being ever perfectly deteſted by him in others, and religiouſly declined in all his writings.

ABOUT this time alſo *Philaretus* began to be taught ſome ſkill in the muſic, both of the voice, and hand; but the diſcouragement of a bad voice quickly perſuaded him to deſiſt. It was now the ſpring of the year, when news was brought to *Stalbridge* of the approach of his ſiſter, the lady *Goring*, and in her company two of his brothers, the lords of *Kinelmeaky* and of *Broghill*, then newly returned from their three years travels. In their company arrived one Mr. *Marcombes*, a French gentleman, who had been their governor, and behaved himſelf ſo handſomly in that relation, that the old earl removed *Philaretus* (his brother lying ſick at a doctor's houſe) to his own houſe again, and intruſted his whole education with this gentleman. He was a man, whoſe garb, his mien, and outſide, had very much of his nation, having been divers years a traveller and a ſoldier; he was well faſhioned, and very well knew, what belonged to a gentleman. His natural were much better than his acquired parts, though divers of the latter he poſſeſſed, though not in an eminent, yet in a very competent degree. Scholarſhip he wanted not, having in his greener years been a profeſſed ſtudent in divinity; but he was much leſs read in books than men, and hated pedantry as much as any of the ſeven deadly ſins. Thrifty he was extremely, and very ſkilful in the ſlights of thrift; but leſs out of avarice, than a juſt ambition, and not ſo much out of love to money, as a deſire to live handſomly at laſt. His practical ſentiments in divinity were moſt of them very ſound; and if he were given to any vice himſelf, he was careful by ſharply condemning it, to render it uninfectious, being induſtrious, whatſoever he were himſelf, to make his charges virtuous. Before company he was always very civil to his pupils, apt to eclipſe their failings, and ſet off their good qualities to the beſt advantage; but in his private converſation he was Cynically diſpoſed, and a very nice critick both of words and men; which humour he uſed to exerciſe ſo freely with *Philaretus*, that at laſt he forced him to a very cautious and conſiderate way of expreſſing himſelf, which after turned to his no ſmall advantage. The worſt quality he had was his choler, to exceſſes of which he was exceſſively prone; and that being the only paſſion, to which *Philaretus* was much obſerved to be inclined, his deſire to ſhun claſhing with his governor, and his accuſtomedneſs to bear the ſudden ſallies of his impetuous humour, taught our youth ſo to ſubdue that paſſion in himſelf, that he was ſoon able to govern it habitually and with eaſe; the continuance of which conqueſt he much acknowledged to that paſſage of St. *James*, *For the wrath of man worketh not the righteouſneſs of God.* James i. 20. And he was ever a ſtrict obſerver of that precept of the apoſtle, *Let not the ſun go down upon your wrath*; for continued anger turns eaſily to malice; which made him, upon occaſion of this ſentence of St. *Paul*, to ſay, that anger was like the Jewiſh manna, which might be wholeſom for a day or two, but if it were kept long, it would breed worms, and corrupt. With this new governor our *Philaretus* ſpent the greateſt part of the ſummer, partly in reading and interpreting the *Univerſal Hiſtory*, written in Latin, and partly in familiar kind of converſation in French, which *Philaretus* found equally diverting and inſtructive, which was as well conſonant to the humour of his tutor as his own.

ABOUT this time his eldeſt brother, the lord of *Dungarvan*, having at his own charges raiſed a gallant troop of horſe for the king's ſervice in the Scotch expedition, his father ſent two other of his ſons, *Kinelmeaky* and *Broghill*, to accompany him in that ſervice, and deſigned *Philaretus* for the ſame employment; but the ſickneſs of his next elder brother, Mr. *F.* whom he was to go along with in that voyage, defeated all our young man's greedy hopes. During his ſtay at *Stalbridge* all that ſummer, his father, to oblige him to be temperate, by freely giving him the opportunity to be otherwiſe, truſted him with the keys of all his gardens and orchards. And indeed *Philaretus* was little given to greedineſs, either in fruits or ſweetmeats; in the latter he was almoſt abſtemious, and in the former he was very moderate; ſo valuing ſuch niceties and dainties, that though he enjoyed them with delight, he could want them without the leaſt regret. During this pleaſing ſeaſon, when the intermiſſion of his ſtudies allowed *Philaretus* leiſure for recreations, he would very often ſteal away from all company, and ſpend four or five hours alone in the fields, and think at random, making his delighted imagination the buſy ſcene, where ſome romance or other was daily acted; which, though imputed to his melancholy, was in effect but an uſual excurſion of his yet untamed habitude of roving, a cuſtom (as his own experience often and ſadly taught him) much more eaſily contracted, than deſtroyed.

TOWARDS the end of this ſummer, the kingdom having now attained a ſeeming ſettlement by the king's pacification with the Scots, there arrived at *Stalbridge* Sir *Thomas Stafford*, gentleman uſher to the queen, with his lady, to viſit their old friend, the earl of *Cork*, with whom, ere they departed, they concluded a match betwixt his fourth ſon, Mr. *F. B.* and *E. K.* [*Killegrew*] daughter to my lady *S.* by Sir — *K.* and then a maid of honour, both young and handſom. To make his addreſſes to this lady, Mr. *F.* was ſent (and *Philaretus* in his

company) before up to *London*, whither within few weeks they were followed by the earl and his family, of which a great part lived at (the lady *Stafford*'s houſe) the *Savoy*; the reſt (for his family was much encreaſed by the acceſſion of his daughters, the counteſs of *Barrimore* and the lady *Ranelagh*, with their lords and children) were lodged in the adjacent houſes, but took their meals in the *Savoy*, where the old earl kept ſo plentiful a houſe, that in months his accompts for bare houſe-keeping exceeded pounds.

NOT long after his arrival, *Philaretus*'s brother having been ſucceſsful in his addreſſes to his miſtreſs, was, in the preſence of the king and queen, publickly married at court, with all that ſolemnity, that uſually attends matches with maids of honour. But to render this joy as ſhort as it was great, *Philaretus* and his brother were within four days after commanded away for *France*, and after having kiſſed their majeſty's hands, they took a differing farewel of all their friends; the bridegroom extremely afflicted to be ſo ſoon deprived of a joy, which he had taſted but juſt enough of to encreaſe his regrets, by the knowledge of what he was forced from; but *Philaretus* as much ſatisfied to ſee himſelf in a condition to content a curioſity, to which his inclinations did paſſionately addict him. With theſe differing reſentments of their father's commands, accompanied by their governor, two French ſervants, and a lacquey of the ſame country, upon the end of *October*, 1638, they took poſt for *Rye* in *Suſſex*, where the next day hiring a ſhip, though the ſea were not very ſmooth, a proſperous puff of wind did ſafely by the next morning blow them into *France*.

AFTER a ſhort refreſhment at *Dieppe*, they travelled through *Normandy* to the chief city of it, *Rouën*; but by the way received advertiſement of a robbery freſhly committed in a wood, they muſt traverſe by night; but judging the fear of being apprehended would deter the robbers from a ſudden return to the ſame place, after ſo recent a crime, the company quietly continued on their journey to *Rouën*, and arrived ſafely at it; where, amongſt other ſingularities, *Philaretus* took much notice of a great floating bridge, which riſing and falling as the tide-water does, he uſed to reſemble to the vain amoriſts of outward greatneſs, whoſe ſpirits reſent all the floods and ebbs of that fortune it is built on. From *Rouën* they paſſed to *Paris*, and having ſpent ſome time in viſiting that vaſt chaos of a city, they ſhaped their courſe for *Lyons*, where, after nine days unintermitted travel, they arrived, having by the way (beſides divers conſiderable places) paſſed by the town of *Moulins* (here famed enough for the fine tweezes it ſupplies us with) a part of the French *Arcadia*, the pleaſant *Pays de Foreſt*, where the marquis *d'Urfé* was pleaſed to lay the ſcene of the adventures and amours of that *Aſtrea*, with whom ſo many gallants are ſtill in love, ſo long after both his and her deceaſe: being alſo by the way uſefully diverted by the company of two Polonian princes, who had as well a right unto that title by their virtue and their education, as their birth.

AFTER ſome ſtay at *Lyons* (a town of great reſort, and no leſs trading, but fitter for the reſidence of merchants than of gentlemen) they traverſed thoſe lofty mountains, that formerly belonging to the duke of *Savoy*, were now by ſtipulation (in exchange of the marquiſate of *Saluzzo*) devolved to the French king; and having by the way beheld that famous place, where the ſwifteſt and one of the nobleſt rivers of *Europe*, the *Rhoſne*, is ſo ſtreightned betwixt two neighbour rocks, that it is no ſuch large ſtride to ſtand on both his banks, the third day after their departure from *Lyons*, they arrived ſafely at *Geneva*, a little commonwealth, which their early embracing and conſtant profeſſion of the reformed religion, together with that peculiar care of providence, in ſo long and ſo unlikely a preſervation, has rendred very much the theme, not only of diſcourſe, but ſome degree of wonder.

Philaretus's inſtructions commanding him a long ſtay in this place, his governor (having both a wife and children in the town) provided him lodgings and entertainment in his own houſe, and at ſet hours taught him both rhetoric and logic, whoſe elements (not the expoſitions) *Philaretus* wrote out with his own hand; though afterwards he eſteemed both thoſe arts, as they are vulgarly handled, not only unſeaſonably taught, but obnoxious to thoſe inconveniences, and guilty of thoſe defects, he does fully particularize in his *Eſſays*. After theſe ſlighter ſtudies, he fell to learn the mathematics, and in a few months grew very well acquainted with the moſt uſeful part of arithmetic, geometry, with its ſubordinates, the doctrine of the ſphere, that of the globe, and fortification; in all which being inſtructed by a perſon, that had a greater regard for his ſcholar's proficiency, than the gains he might derive from the common tedious and dilatory way of teaching, he quickly grew ſo enamoured of thoſe delightful ſtudies, that they very often proved both his buſineſs and his diverſion in his travels, and he afterwards improved his opportunities to the attainment of a more than ordinary ſkill in divers of them. He alſo frequently converſed with a voluminous, but excellent French book, called, *Le Monde*, which ſo judiciouſly informs its readers, both of the paſt and preſent condition of all thoſe ſtates, that now poſſeſs our globe, and by a delectable and inſtructive variety not only ſatisfies men's curioſity, but ſo copiouſly ſupplies them with matter, both of curious and ſerious diſcourſe, that he uſed to ſay of that book, that it was worth its title, which means, *The World*.

BUT to employ his body, as well as his mind, becauſe *Philaretus*'s age was yet unripe for ſo rude and violent an exerciſe as the great horſe, he ſpent ſome months in fencing, and ten or twelve in learning to dance, the former of which exerciſes he ever as much affected, as he contemned the latter. His recreations, during his ſtay at *Geneva*, were ſometimes mall, tennis,

tennis, (a ſport he ever paſſionately loved) and, above all, the reading of romances, whoſe peruſal did not only extremely divert him, but (aſſiſted by a total diſcontinuance of the Engliſh tongue) in a ſhort time taught him a ſkill in French ſomewhat unuſual to ſtrangers. In effect, before he quitted France, he attained a readineſs in the language of that country, which enabled him, when he made concealment his deſign, to paſs for a native of it, both amongſt them that were ſo, and amongſt foreigners alſo; and in all his writings, whilſt he was abroad, he ſtill made uſe of the French tongue, not out of any intention to improve his knowledge in it, but becauſe it was that he could expreſs himſelf beſt in.

BUT during *Philaretus*'s reſidence at *Geneva*, there happened to him an accident, which he always uſed to mention as the conſiderableſt of his whole life. To frame a right apprehenſion of this, you muſt underſtand, that though his inclinations were ever virtuous, and his life free from ſcandal, and inoffenſive, yet had the piety he was maſter of already ſo diverted him from aſpiring unto more, that Chriſt, who long had lain aſleep in his conſcience (as he once did in the ſhip) muſt now, as then, be waked by a ſtorm. For at a time, which (being the very heat of ſummer) promiſed nothing leſs, about the dead of night, that adds moſt terror to ſuch accidents, *Philaretus* was ſuddenly waked in a fright with ſuch loud claps of thunder (which are oftentimes very terrible in thoſe hot climes and ſeaſons) that he thought the earth would owe an ague to the air, and every clap was both preceded and attended with flaſhes of lightning ſo frequent and ſo dazzling, that *Philaretus* began to imagine them the ſallies of that fire, that muſt conſume the world. The long continuance of that diſmal tempeſt, where the winds were ſo loud, as almoſt drowned the noiſe of the very thunder, and the ſhowers ſo hideous, as almoſt quenched the lightning, ere it could reach his eyes, confirmed *Philaretus* in his apprehenſions of the day of judgment's being at hand. Whereupon the conſideration of his unpreparedneſs to welcome it, and the hideouſneſs of being ſurpriſed by it in an unfit condition, made him reſolve and vow, that if his fears were that night diſappointed, all his further additions to his life ſhould be more religiouſly and watchfully employed. The morning came, and a ſerener cloudleſs ſky returned, when he ratified his determination ſo ſolemnly, that from that day he dated his converſion, renewing, now he was paſt danger, the vow he had made, whilſt he believed himſelf to be in it; that though his fear was (and he bluſhed it was ſo) the occaſion of his reſolution of amendment, yet at leaſt he might not owe his more deliberate conſecration of himſelf to piety to any leſs noble motive, than that of its own excellence.

THUS had this happy ſtorm an operation upon *Philaretus*, reſembling that it had upon the ground; for the thunder did but terrify, and blaſted not; but with it fell ſuch kind and genial ſhowers, as watered his parched and almoſt withered graces, and reviving their greenneſs, ſoon rendered them both flouriſhing and fruitful. And though his boiling youth did often very earneſtly ſolicit to be employed in thoſe culpable delights, that are uſual in, and ſeem ſo proper for that ſeaſon, and have repentance adjourned till old age; yet did its importunities meet ever with denials, *Philaretus* ever eſteeming, that piety was to be embraced, not ſo much to gain heaven, as to ſerve God with. And I remember, that being once in company with a crew of mad young fellows, when one of them was ſaying to him, what a fine thing it were, if men could ſin ſecurely all their life time, by being ſure of leiſure to repent upon their death-beds; *Philaretus* preſently replied, that truly for his part he ſhould not like ſinning, though on thoſe terms, and would not all that while deprive himſelf of the ſatisfaction of ſerving God, to enjoy ſo many years fruition of the world. In effect it is ſtrange, that men ſhould take it for an inducement to an action, that they are confident, that they ſhall repent of it. But *Philaretus* himſelf having ſufficiently diſcourſed that point of early piety, in the ſixth treatiſe of his *Chriſtian Gentleman*, I ſhall at preſent not only add to the arguments you may find there alledged, that he uſed to ſay, that it was a kind of meanneſs in devotion, to conſider the very joys of the other life more as a condition, than a recompenſe. But (as when in ſummer we take up our graſs-horſes into the ſtable, and give them ſtore of oats, it is a ſign, that we mean to travel them) our *P.* ſoon after he had received this new ſtrength, found a new weight to ſupport; for ſpending ſome of the ſpring in a viſit to *Chambery*, the chief town of *Savoy*; *Aix* famed for its baths; *Grenoble*, the head town of *Dauphiné*, and reſidence of a parliament, his curioſity at laſt led him to thoſe wild mountains, where the firſt and chiefeſt of the Carthuſian abbies does ſtand ſeated; where the devil taking advantage of that deep raving melancholy, ſo ſad a place, his humour, and the ſtrange ſtories and pictures he found there of *Bruno*, the father of that order, ſuggeſted ſuch ſtrange and hideous thoughts, and ſuch diſtracting doubts of ſome of the fundamentals of Chriſtianity, that, though his looks did little betray his thoughts, nothing but the forbiddenneſs of ſelf-diſpatch hindered his acting it. But after a tedious languiſhment of many months in this tedious perplexity, at laſt it pleaſed God, one day he had received the ſacrament, to reſtore unto him the withdrawn ſenſe of his favour. But though ſince then *Philaretus* ever looked upon theſe impious ſuggeſtions, rather as temptations to be ſuppreſſed, than doubts to be reſolved; yet never after did theſe fleeting clouds ceaſe now and then to darken the cleareſt ſerenity of his quiet, which made him often ſay, that injections of this nature were ſuch a diſeaſe to his faith, as the tooth-ach is to the body; for though it be not mortal, it is very troubleſom. And however, as all things work together to them that love

God) *Philaretus* derived from this anxiety the advantage of groundedneſs in his religion: for the perplexity his doubts created obliged him, to remove them, to be ſeriouſly inquiſitive of the truth of the very fundamentals of Chriſtianity, and to hear what both Turks, and Jews, and the chief ſects of Chriſtians could alledge for their ſeveral opinions; that ſo, though he believed more than he could comprehend, he might not believe more than he could prove, and not owe the ſtedfaſtneſs of his faith to ſo poor a cauſe, as the ignorance of what might be objected againſt it. He ſaid (ſpeaking of thoſe perſons, that want not means to enquire, and abilities to judge,) that it was not a greater happineſs to inherit a good religion, than it was a fault to have it only by inheritance, and think it the beſt, becauſe it is generally embraced, rather than embrace it, becauſe we know it to be the beſt. That though we cannot always give a reaſon for what we believe, we ſhould be ever able to give a reaſon why we believe it. That it is the greateſt of follies to neglect any diligence, that may prevent the being miſtaken, where it is the greateſt of miſeries to be deceived. That how dear ſoever things taken up on the ſcore are ſold, there is nothing worſe taken up upon truſt than religion, in which he deſerves not to meet with the true one, that cares not to examine whether or no it be ſo.

AND now *Philaretus* having ſpent one and twenty months in *Geneva*, about the middle of September 1641 departed towards *Italy*, and having traverſed *Swizerland*, and by the way ſeen *Lauſanne* (an academy ſeated upon the great Genevan lake) *Zurich*, and *Soleurre*, the heads of Cantons wearing the ſame name, and wandered ſeven or eight days amongſt thoſe hideous mountains, where the *Rhoſne* takes it ſource, and he ſaw the *Rhine* but a brook; he at length arrived at the *Valtollina*, a ſpacious valley walled round with the ſteep *Alpes*, but ſo delicious, and (eſpecially in that ſeaſon) ſo crowned with all that *Ceres* and *Bacchus* are able to preſent, that it deſerved to be the motive, but not the ſtage of thoſe late wars it has occaſioned betwixt the rival crowns of *France* and *Spain*. There *Philaretus* had the curioſity to viſit, the place on which ſtood *Piur*, a pleaſant little town, once eſteemed for its deliciouſneſs, but now much more and more meritedly famous for its ruin, which happened ſome two dozen of years ſince, by the ſudden and unexpected fall of a neighbouring hill upon it, which ſtruck the whole town ſo deep into the ground, that no after-ſearch by digging has ever prevailed to reach it. Having viſited the ſingularities of this earthly paradiſe, *Philaretus* and his company began to climb that mountain of the *Alpes*, which denominated from a town, that is ſeated upon its foot, is uſually called, *La montagna di Morbegno*. The hill was eight miles in aſcent, and double that number downwards. It was then free from ſnow; but all the neighbouring hills, where ſtore of cryſtal is digged, like perpetual penitents, do all the year wear white. Upon the top of this hill, which is entirely uninhabited, *Philaretus* had the pleaſure to ſee the clouds, which they paſſed through in their deſcent, beneath them darkning the middle of the mountain, while on the top they had a clear ſerenity. But notwithſtanding the fairneſs of the day, they ſpent it all in traverſing this hill, at the height of which they left the *Griſons* territory, and at the bottom entered a village belonging to that of the *Venetians*; but having paſſed through ſuch a purgatory as the *Alpes* to their Italian paradiſe, I cannot but ſuppoſe them ſomewhat weary, and ſo my pen obliged to let them and it ſelf take ſome ſhort reſt.

Philaretus being thus entred into the vaſt and delicious plains of *Lombardy*, traverſed the greateſt part of that rich province, and having ſtayed the ſtomach of his curioſity with the obſervables of *Bergamo*, *Breſcia*, *Verona*, *Vincenza*, and *Padua* (a famous univerſity, but more peculiarly devoted to *Æſculapius* than *Minerva*'s arts) he gave it a full meal at *Venice*, where the great concourſe of foreign nations numerouſly reſorting thither for trade or nobler buſineſs, preſents the ſenſes with a no leſs pleaſing than conſtant variety. From *Venice* returning through *Padua*, and paſſing through *Bologna* and *Ferrara* (towns, whoſe names allow me to ſpare their characters) he at laſt arrived at *Florence*, with a determination (having diſpoſed of the horſes he rode on from *Geneva* thither) to paſs the winter there. *Florence* is a city, to which nature has not grudged a pleaſing ſituation, and in which architecture has been no niggard either of coſt or ſkill, but has ſo induſtriouſly and ſumptuouſly improved the advantages liberally conferred by nature, that both the ſeat and buildings of the town abundantly juſtify the title the Italians have given it of *Fair*. Here *Philaretus* ſpent much of his time in learning of his governor (who ſpake it perfectly) the Italian tongue, in which he quickly attained a native accent, and knowledge enough to underſtand both books and men; but to ſpeak and expreſs himſelf readily in that language was a ſkill, he ever too little aſpired to acquire. The reſt of his ſpare hours he ſpent in reading the modern hiſtory in Italian, and the new paradoxes of the great ſtar-gazer *Galileo*, whoſe ingenious books, perhaps becauſe they could not be ſo otherwiſe, were confuted by a decree from *Rome*; his highneſs the Pope, it ſeems, preſuming, and that juſtly, that the infallibillity of his chair extended equally to determine points in philoſophy, as in religion, and loth to have the ſtability of that earth queſtioned, in which he had eſtabliſhed his kingdom. Whilſt *Philaretus* lived at *Florence*, this famous *Galileo* died * within a league of it, his memory being honoured with a celebrating epitaph, and a fair tomb erected for him at the publick charges; but before his death being long grown blind, to certain friers (a tribe, whom for their vices and impoſtures he long had hated) that reproached him with his blindneſs, as a juſt puniſhment of

* He died January the 8th, 1641-2, N. S. See *General Dictionary*, Vol. V. p. 373. in the article of *Galileo*.

heaven incenſed for being ſo narrowly pried into by him, he anſwered, that he had the ſatiſfaction of not being blind, till he had ſeen in heaven what never mortal eyes beheld before. But to return to *Philaretus*, the company of certain Jewiſh rabbins, who lodged under the ſame roof with him, gave him the opportunity of acquainting himſelf with divers of their arguments and tenents, and a riſe of further diſquiſitions in that point. When carnaval was come (the ſeaſon, when madneſs is ſo general in *Italy*, that lunacy does for that time loſe its name) he had the pleaſure to ſee the tilts maintained by the Great Duke's brothers, and to be preſent at the gentlemen's balls. Nor did he ſometimes ſcruple, in his governor's company, to viſit the famouſeſt *Bordellos*, whither reſorting out of bare curioſity, he retained there an unblemiſhed chaſtity, and ſtill returned thence as honeſt as he went thither, profeſſing, that he never found any ſuch ſermons againſt them, as they were againſt themſelves; the impudent nakedneſs of vice clothing it with a deformity, deſcription cannot reach, and the worſt of epithets cannot but flatter. But though *Philaretus* were no fuel for forbidden flames, he proved the object of unnatural ones; for being at that time in the flower of youth, and the cares of the world having not yet faded a complexion naturally freſh enough, as he was once unaccompanied diverting himſelf abroad, he was ſomewhat rudely preſſed by the prepoſterous courtſhip of two friers, whoſe luſt makes no diſtinction of ſexes, but that, which its preference of their own creates, and not without difficulty and danger forced a ſcape from thoſe gowned Sodomites, whoſe goatiſh heats ſerved not a little to arm *Philaretus* againſt ſuch people's ſpecious hypocriſy, and heightened and fortified in him an averſeneſs for opinions, which now the religieux diſcredit as well as the religion.

Philaretus having thus ſpent the winter in *Florence*, towards the end of March began his journey to *Rome*; and having paſſed thorough and ſeen the ſingularities of *Sienna*, *Montefiaſcone*, and ſome other remarkable places in his paſſage, at the end of five days he ſafely arrived at that imperious theme of fame, which deſtinated to ſome kind or other of univerſal monarchy, is now no leſs conſiderable by its preſent ſuperſtition, than formerly by its victorious arms; the modern Popes bringing it as high a veneration as the ancient Cæſars, and the Barberine bees flying as far as did the Roman eagles. The more conveniently to ſee the numerous rarities of this univerſal city, *Philaretus*, to decline the diſtracting intruſions and importunities of Engliſh Jeſuits, paſſed for a Frenchman, which neither his habit nor language much contradicted. Under this notion he delightfully payed his viſits to what in *Rome* and the adjacent villages moſt deſerved them, and amongſt other curioſities and antiquities had the fortune to ſee the Pope at chapel, with the Cardinals, who ſeverally appearing mighty princes, in that aſſembly looked like a company of common friers. Here *Philaretus* could not chuſe but ſmile to ſee a young churchman, after the ſervice ended, upon his knees carefully with his feet ſweep into his handkerchief the duſt, his holineſs's gouty feet had by treading on it conſecrated, as if it had been ſome miraculous relick. Nor was *Philaretus* negligent to procure the Latin and Tuſcan poems of this Pope, whoſe name *Urbanus* his actions did not belie, he having more of the gentleman in him, than his pontifical habit would ſeem to let him wear. A poet he was, and a * * * * *

* * * HE never found the Pope leſs valued than in *Rome*, nor his religion fiercelier diſputed againſt than in *Italy*; and ſometimes added, that he ceaſed to wonder, that the Pope ſhould forbid the ſight of *Rome* to proteſtants, ſince nothing could more confirm them in their religion.

Philaretus having in a ſhort time ſurveyed the principal rarities of this proud miſtreſs of the world, was unwillingly driven thence by his brother's diſability to ſupport the encreaſing heats, which there prove often inſupportable to ſtrangers, the neighbouring country being very ſcorched, and barren, and uninhabited. Wherefore he took his way back towards *Florence*, by that delicious valley that ennobles *Perugia*, and paſſing by *Piſtoia* came to *Florence*, where, after a ſhort repoſe, they deſcended the river *Arno* into *Piſa*, and from thence to *Livorno*, where in a Felucca, with a good wind, they ventured, for expedition ſake, ſome fifteen or ſix miles into the ſea, and coaſting along the country, ſtill near the ſhore for fear of ſudden ſtorms, they each night lay in ſome town, drawing their boat aſhore (which was not uneaſy in regard of the inconſiderable tides of the Mediterranean there) and ſoon, though not without danger, reached proud *Genoa*. * * * * *

* * * * * THE next day *Philaretus* proſecuted his journey, and paſſing by *Monaco* (a very ſtrong place, then newly betrayed by the prince to the French) and by *Meatone*, a little principality belonging to the ſame prince, and ſtopping a while at *Nizza*, a place extremely and meritoriouſly famous for that ſtrength, which nature and art have emulouſly given it, by night they landed at *Antibe*, one of the towns of *France*, that moſt approaches *Italy*.

THE morning, that ſucceeded *Philaretus*'s arrival at *Antibe*, he left it to croſs the country to *Marſeilles*, but he was welcomed into *France*, by an accident, which was very hazardous, and might have proved tragical. During the whole time of his being a traveller, or reſident in *Italy*, *Philaretus* had religiouſly adhered to his * * * *

* * * * ENGLISH gentlemen thinking it as much better as ſafer to take off their hats, than to venture their heads, complimented with the crucifix; but *Philaretus*, without the leaſt act of ſuperſtition, though not without ill words, and worſe menaces, ventured and paſt boldly thorough them all, as ever reſolving, that the ſoul ſhould not more tranſcend the body in its own value, than in his eſteem. This danger thus happily eſcaped, *Philaretus* continues his way

way to *Marſeilles*, where the third day he arrived, with intent there to expect bills of exchange promiſed to be then ſent thither, to enable him to proſecute his future travels. His detention here was ſhortned by his viſits of ſo excellent a harbour for gallies and ſmall veſſels: * * * Town every night like it aſſured with lock and key. Here *Philaretus* had the pleaſure to ſee the French king's fleet of gallies put to ſea, and about two thouſand poor ſlaves tug at the oar to row them.

HERE unfortunately Mr. *Boyle*'s manuſcript memoirs break off abruptly, which I ſhall endeavour to continue from ſuch lights, as his other papers afford me.

DURING his travels, he purſued his ſtudies with great vigour; and his brother *Francis*, afterwards lord *Shannon*, uſed to ſay, that even then he would never loſe any vacant time; for if they were upon the road, and walking down a hill, or in a rough way, he would read all the way; and when they came at night to their inn, he would ſtill be ſtudying till ſupper, and frequently propoſe ſuch difficulties, as he met with in his reading, to his governor (*s*).

IN *Italy* he read over the lives of the ancient philoſophers with the utmoſt attention. The ſect, which then ſtruck him moſt, was that of the Stoics; and he tried his proficiency in their philoſophy, by enduring a long fit of the tooth-ach with great unconcernedneſs (*t*). At *Marſeilles*, he and his brother *Shannon* were obliged to wait for bills of exchange, in order to proſecute their journey; but, inſtead of that ſupply, they received from their father, in May 1642, a ſad relation of the general rebellion in *Ireland*, with this account, that it was with great difficulty he had procured for them two hundred and fifty pounds, to ſupply their expences in their return home. But this money being intruſted with one *Perkins*, a citizen of *London*, who was eſteemed a man of conſiderable ſubſtance, to be ſent them in bills of exchange, he proved unfaithful, ſo that they never received the leaſt part of it. Being thus left deſtitute in a ſtrange country, ſeven or eight hundred miles from home, they were by means of Mr. *Marcombes* their governor brought to *Geneva*, till ſupplies could be received to enable them to return; where, by reaſon of the dreadful confuſion of affairs in *Ireland* and *England*, they fruitleſsly waited for about two years; during all which time having no money, either to diſcharge Mr. *Marcombes*, or to return homewards, they were obliged to live at a great expence, and to run in debt to him on that account. "At length, adds Mr. *Boyle* (*u*), though I could "not receive any ſupply at all from my friends, yet being unable to ſubſiſt any longer, I was "forced to remove thence; and having upon his [Mr. *Marcombes*'s] credit made ſhift to take "up ſome ſlight jewels at a reaſonable rate, we made ſale of them from place to place, and "by their help, at laſt, by God's aſſiſtance, we got ſafe into *England* towards the middle of "the year 1644, where we found things in ſuch confuſion, that although the manor of *Stal-*"*bridge* were, by my father's deceaſe, deſcended unto me, yet it was near four months before I "could get thither."

UPON his return to *England*, which was unexpected to all his relations, he went immediately to his beloved ſiſter *Catharine*, viſcounteſs *Ranelagh*, a lady remarkable for her uncommon genius and knowledge, in whoſe houſe he lodged four months and an half. It was by accident, that he found her out, but ſuch an accident, as he frequently afterwards, with great thankfulneſs to the providence of God, uſed to aſcribe a good part of his future happineſs to. For had he not been ſo detained, he had gone into the army, where though there were, beſides "the excellent king himſelf, divers eminent divines, and many worthy "perſons of ſeveral ranks; yet the generality of thoſe he would have been obliged to converſe "with, were very debauched, and apt, as well as inclinable, to make others ſo (*x*);" whereas by ſtaying in *London* in a family, that was ſtrictly religious, his early years were ſeaſoned with ſuch principles of piety and virtue, as never forſook him during the reſt of his life. He reaped alſo a collateral advantage by it, which was, that a ſiſter-in-law of lady *Ranelagh*, who was with them in the houſe, and was wife of one of the principal members of the then houſe of commons, brought him into the acquaintance and friendſhip of ſome great men of that party, which was then growing, and ſoon after victorious; by whoſe means he got early protection for his Engliſh and Iriſh eſtates (*y*). However it is probable from a letter of his to his brother lord *Broghill*, dated from *London*, Aug. 25th, 1645, which begins thus, "The "neceſſities of my affairs calling me away (according to the leave the parliament has given "me) into *France*," that he went abroad again, poſſibly to ſettle his accounts with Mr. *Marcombes*, who, as is already obſerved, had advanced money, and engaged his credit for him. But he did not continue long out of *England*; for he was at *Cambridge* for a ſhort time in December following. In March, 1645-6 he retired to his manor at *Stalbridge*; where he reſided for the moſt part till *May* 1650; and upon his arrival there wrote the following letter to his ſiſter, the lady *Ranelagh*, which will ſhew his talent in the epiſtolary ſtyle, even at that early age.

(*s*) Dr. *Dent*'s letter to Dr. *W. Wotton*, dated from *Weſtminſter Abbey*, May 20, 1699.

(*t*) Mr. *Boyle*'s memorandums of his own life, dictated by himſelf to biſhop *Burnet*.

(*u*) Letter to the ſteward of his manor of *Stalbridge* in *Dorſetſhire*.

(*x*) Papers of Mr. *Boyle*'s life, delivered by him to biſhop *Burnet*.

(*y*) Ibid.

"SISTER,

"IF the buſy idleneſs of receiving ſenſeleſs viſits (whoſe continuance, if otherwiſe unavoidable, were capable, in my opinion, to juſtify the retiredneſs of an hermit) had "not ſo totally taken up my leiſure, you ſhould not ſo long have had a reprieve from the "importunity of my letters. But now at laſt, to make you amends for my fault (if at leaſt

"the

" the amends itſelf be not a fault) I will preſent you with a piece of a real romance in the
" ſtory of my peregrination hither. The morning I had the unhappineſs to take my leave of
" you and my lady *Molkin*, I bid farewel to the city, and began my journey upon a courſer.
" Him I rid to dinner to *Egham*; and at the end of the town, there it was my good fortune
" (as we are pleaſed to miſcall it) to overtake an expreſs ſent from the parliament to the ge-
" neral, making ceremonies with his horſe, whether of them two ſhould lead the way. I
" quickly put an end to their difference, by making *Roger* take the honour upon him; and
" we had not rid far, before we met with ſome carriers, that had lately left *Andover*, who aſſured
" us, that the way was very ſecure; though preſently after we came to diſcover, that thoſe
" youngſters would not have been very ſorry, that we had been ſnapped by ſome of their
" party, and been made to take *Oxford* in our way to *Stalbridge*; for we were no ſooner
" come to *Bagſhot*, but we met a carrier coming the way we were going, who aſſured us, that
" the cavaliers had eaſed them at *Baſingſtoke* of all their ſuperfluous moveables, and were
" advanced as far as *Hartley-row*, the very village, that I had deſigned for that night's lodging.
" So believing, that our quarters would be already taken up, we called a council of war to ad-
" viſe and reſolve what to do. It was *Roger*'s opinion, to ſtay where we were, till the paſſage
" were made ſecure (ſtrange, that ſo well-armed an head ſhould be fearful!) but the meſſen-
" ger eaſily perſuaded us to go to *Farnham* (though both that and all the country in the way
" were ſmartly alarmed) aſſuring *Roger*, that in caſe of danger he could ſtrike into a way,
" out of the way, to bring us to the place we went to. As we went along, we met divers
" little parties, with whom we exchanged fears, and found, that the malignant humours, that
" were then abroad, had frighted the country into a ſhaking ague, till we came to *Farnham*,
" which we found empty and unguarded, all the townſmen being gone out to oppoſe the
" king's party, and chuſing rather to have their houſes empty, than repleniſhed with ſuch
" gueſts, as otherwiſe they were neceſſarily to expect. There invited by the coolneſs of the
" evening, and the freſhneſs of the garden I was walking in, I almoſt loſt myſelf in medi-
" tating, how fooliſhly raſh were our controlments of, and repinings at the wiſe contrivances
" of that all-ſwaying providence, whoſe proceedings ſhould be as far above our cenſures,
" as they are above our reach. How apt are we, upon the leaſt thwarting of our deſigns, to
" murmur againſt providence, and in a pettiſh humour throw themſelves after the hatchet,
" *le manche apres la coignée*, and give ourſelves for gone, when, had we had our will in the
" means, we ſhould have been fruſtrate in our expectation of the end! Whereas that ſuper-
" lative wiſdom, that we grumble at for thwarting us in the means, by croſſing us in the way,
" brings us the ſooner to our journey's end. With divers contemplations upon this ſubject,
" I went to ſupper, and thence to bed, not without ſome little fear of having our quarters
" beaten up by the cavaliers that night; when lo! to ſecond my apprehenſions, about the
" dead of my ſleep, and that night, I heard a thundering at the door, as if they meant to
" fright it out of the hinges, and us out of our wits. I preſently leaped out of my bed,
" in my ſtockings and clothes (my uſual night-poſture, when I travel;) and while *Roger*
" was lighting a candle, got my bilboa and other inſtruments from under my pillow: where-
" upon *Roger* opening the door, ſaw it beſet with muſketeers, who no ſooner ſaw us, but
" ſaid aloud, that we were not the men they looked for; and being intreated to come into
" the chamber, refuſed it, and he, that brought them thither, excuſed their troubling us,
" with as tranſcendent complements as the brown bill could afford. I wondered at their cour-
" teſy, till I knew, that it was the town-conſtable, that, making a ſearch for ſome ſuſpicious
" perſons, and coming by my chamber, that wanted a lock, either had a mind to make us
" take notice of ſo conſiderable an officer, or no mind that we ſhould ſleep, whilſt our bet-
" ters watched; and for his not coming in, ſome accents of fear, that *fell from* him, made
" me ſuſpect I was obliged for that to myſelf; and I remember, that juſt at the opening of
" the door, he peeping in, eſpied me drawing a piſtol out of one of my holſters, which, I
" believe, made him ſo niggardly of his company. Well, away went my gentleman in pro-
" ſecution of his ſearch, and I e'en took my bows and arrows, and went to ſleep. The next
" day we dined at *Wincheſter*, and ever and anon, by the trembling paſſengers we met, were
" as nicely catechized concerning our ways, as if we were to be elected in the number of the
" new lay elders. From thence we reached *Saliſbury* that night, though before we came
" thither, we were fain to paſs in the dark through a wood, where we had warning given us,
" that about an hundred woodmen (we have got wild Engliſh too now) lay leiger, where
" theſe night-birds uſed to exerciſe their charity in eaſing weary travellers of ſuch burthenſom
" things as money and portmanteaus. There was nothing in all my journey vext me ſo much
" as the gravity of my ſteed; for though he were none of the freeſt of his legs, yet he kept
" my body in a reſtleſs agitation, which was none of the pleaſanteſt in the world neither;
" and if now and then I did ſolicit his ſides, to perſuade him to gallop (a dialect, that his
" feet were utterly unacquainted with) it ſhould be ſhort itſelf, and both uſhered in and epilo-
" gized with ſo long and ſo jolting a trot, that the trouble of it was far greater than the eaſe.
" At *Saliſbury* I overtook my trunks I had ſent thither before; and the next morning took
" them along with me over the plain; where when we had gone about half the way, we were
" ſuddenly environed with a party of horſe (beyond whom we might diſcover a body of foot)
" who came poudering ſo furiouſly upon us, that they ſcarce gave us leiſure to draw; but
" coming nearer, and knowing the ſtate's meſſenger (as he called himſelf) they durſt not

" meddle, neither with us, nor with my trunks, which they eyed though very lovingly; and " had not we been there, would, I believe, have opened to ſearch for malignant letters, ſuch " as uſe to be about the King's picture in a yellow boy. The foot we ſaw were poor preſſed " countrymen, whom this party of horſe were ſent, not to convey, but to guard. Amongſt " them I ſaw one poor rogue, lacqueyed by his wife, and carrying a child upon his ſhoulders. " A pretty device, methinks, to make thoſe, who have no goods, to fight for their wives " and children! Good God! that reaſonable creatures, that call themſelves Chriſtians too, " ſhould delight in ſuch an unnatural thing as war, where cruelty at leaſt becomes neceſſity, " and unprocured poverty becomes a crime; and a man with his whole family muſt be ſub- " ject to be unavoidably undone, becauſe the violence perhaps of thoſe very ſoldiers, that preſs " him, had made him poor. At laſt on Saturday night I arrived, God be praiſed, at *Stal-* " *bridge*, and found by experience the truth of that ſenſeleſs proverb, the longeſt way about " is the neareſt way home. And here the fair weather, that had been my conſtant companion " from *London* hither, as ſoon as it ſaw me houſed, took leave of me; in whoſe abſence " winter weather has always ſo fully and uninterruptedly domineered, that we all ſuſpect the " almanack-maker of a miſtake, in ſetting down March inſtead of January. It confines me to " my chamber, and is ſo drooping, that it dulls me to all kinds of uſeful ſtudy, and (which is " worſt of all) it renders me obnoxious to theſe country viſits (or viſitations rather) which, " you know, uſe to ſupply with their length what they want in their goodneſs. As ſoon as " the weather will give me leave, I intend to take *Marſton Bigot* in my way to *Briſtol*, to put " ſome end or other to the buſineſs—— I am loaded with civil language and fair promiſes; " but I have always obſerved, that in the troopers dictionary the pages are ſo cloſe and thick " written with promiſes, that there is no room left for ſuch a word as performance.

" My *Ethics* * go very ſlowly on; neither have I been poſſibly able to do any other buſi- " neſs, ſave to make my brother's ſixty trees bear him ſome golden fruit, of which, (though " I did my uttermoſt endeavour to ripen it) I muſt gather but one third at May-day next, the " other at &c.

" My ſtay here, God willing, ſhall not be long, this country being generally infected with " three epidemical diſeaſes (beſides that old leiger ſickneſs, the troop-flux) namely the plague, " which now begins to revive again at *Briſtol* and *Yeovil* ſix miles off, fits of the committee, " and conſumption of the purſe; to which ſo violent expulſives, if ſo potent an attractive, as " a letter from you, were but added, it would both extremely ſweeten the ſtay, and accelerate " the departure of,

" My deareſt ſiſter,

" your moſt affectionate brother,

Stalbridge, March 30, 1646.

" and humble ſervant,

" ROBERT BOYLE.

DURING his retirement at *Stalbridge*, he applied himſelf with great vigour to his ſtudies of various kinds, particularly thoſe of natural philoſophy and chemiſtry. Nor did he neglect to keep up a correſpondence with his friends by letters, ſome of which are extant of ſo early a date as the year 1646, wherein he not only gives an account of his ſtudies, but likewiſe diſcovers a great penetration, and a very ſolid judgment, concerning men and things, far above his age. And though he meddled as little as poſſible with politics, yet his intereſt, his good nature, and his piety, would not ſuffer him to be an unconcerned ſpectator of thoſe miſeries, under which his country groaned; and in ſome of his remarks on men's preſages concerning the conſequences of the war, and their expectation of a ſettled peace, he paſſed a true judgment, founded on wiſe and ſolid reaſons, and verified by the event. For however many of his friends flattered themſelves with an happy iſſue of the war, he had all along different apprehenſions of it. I ſhall inſert therefore ſome extracts of the letters, according to theſe dates of them. The firſt was written to Mr. *Marcombes*, October 22, 1646, from *London*, where he then was.

" MONSIEUR,

" SINCE diſcountenance of the practice of your language has robbed me of that little " readineſs your converſe had taught me in it, I ſhall take the liberty to make uſe of " mine, which I know you underſtand equally with your own.

" IN my laſt I promiſed you a more full account of ſundry particulars, I had then the leiſure " but to touch at; and for my diſengagement I ſhall tell you, that we are in a very doubtful " condition for the preſent, though in all probability a few days will determine either our " hopes or our fears. In *England* the great and uninterrupted ſucceſſes have tranſcended as " well their own hopes, as their oppoſers fears. In *England* there is not one malignant " gariſon untaken, and in *Wales* but two or three rocky places hold out for the King, and " theſe too ſo inconſiderable, that they more advantage their enemies forces, by keeping them

* A treatiſe, which he was then compoſing on that ſubject, and ſtill extant in his own hand-writing. This was one of his firſt books, and was begun before he was twenty years of age.

" from idleneſs, than they are able to prejudice them by their oppoſition. The Scots being " now to quit the kingdom, the parliament had compounded with them for all their arrears, " upon whoſe payment they are to deliver up their gariſons, and retire into their own coun- " try. The ſum total, being in all 300,000 l. is already agreed upon; but the firſt payment " is yet in debate. His majeſty is ſtill at *Newcaſtle*, both diſcontenting and diſcontented; " and the Scots will now, upon their departure out of *England*, be forced ſome way or other to " diſpoſe of his perſon, which the houſes have here voted to remain at the diſpoſition of both " houſes of parliament. The greater part of men in theſe parts are pleaſed to flatter them- " ſelves with the hopes of a ſpeedy ſettlement of things; but for my part, that have always " looked upon ſin as the chief incendiary of the war, and yet have by careful experience ob- " ſerved the war to multiply and heighten thoſe ſins, to which it owes its being, as water and " ice, which by a reciprocal generation beget one another, I cannot without preſumption ex- " pect a recovery in that body, where the phyſic, that ſhould cure, but augments the diſeaſe. " And this opinion of mine is over and above grounded upon ſuch politic conſiderations, " (though known to very few beſides my ſelf) that in this I muſt even wiſh to have leſs " reaſon on my ſide. Thoſe, that appear for the King in *Scotland*, are bodied in an army of " above 8000 men; a power ſo formidable in that country, that certainly, if by the Scots ill " uſage to his Majeſty it be provoked, it will be able, if not to conquer, at leaſt to ruin that " beggared kingdom.

" As for *Ireland*, the news of my lord of *Ormonde*'s peace with the Iriſh, together with " the articles, upon which it was concluded, have, I am confident, reached *Geneva* long ere " this. But our lateſt intelligence out of thoſe parts informs us, that peace is very likely to " produce its contrary amongſt them that made it, not only by dividing betwixt the Iriſh " and themſelves, for not only the Iriſh attempted, though vainly, to ſurpriſe my lord of " *Ormonde*, and cut off his party, whilſt they were in their quarters; but the beſt general, " and moſt numerous army, together with divers of their greateſt towns, have poſitively " declared againſt the peace; to which the old Engliſh or catholic lords of the Engliſh pale, " (ſo we call the counties about *Dublin*) with many others, have ſubmitted; ſo that theſe " two flints are ſtriking ſuch ſparks, as are like to kindle a fine bonfire for the Engliſh, if " they have the wit but to lay hold on the opportunity, and blow theſe private diſcontents " into a civil war. Now this relation, however it ſeem not to carry with it any great proba- " bility, I am the more apt to believe, becauſe it is credited by the knowledge of the Iriſh " intereſts; for the lords of the pale, though by manners and inclination Iriſh, yet being " Engliſh by deſcent, do with reaſon ſuſpect, that if they give way to a total expulſion or ex- " tirpation of the Engliſh, their turn will come next to drink out of the ſame cup; and there- " fore are very willing, by aſſenting to this peace, to ſecure themſelves from that fear, and " from the manifeſt danger, that threatned them from their nearneſs to *Dublin*, in the pro- " teſtants hands, and the moſt conſiderable place of the kingdom. On the other ſide, the " mere natives promiſed themſelves for the general, by this rebellion, to exchange the throne " of *England* for St. *Peter*'s chair; or at leaſt to ſhake off the *Engliſh* yoke for that of ſome " foreign prince of their own religion; and in particular the nobility had already devoured " in their greedy hopes all the proteſtants eſtates; upon whoſe preſumed acceſſion they built " ſtrange and imaginary caſtles in the air. And the clergy, the main firebrand of this " rebellion, expected no leſs than to be reinſtated into their ancient poſſeſſions; ſo that both " theſe latter parties being thus fruſtrated of their hopes, endeavour to foment among the " people (very fit tinder to catch at ſuch a fire) a diſlike of the preſent peace, which the " former oppoſe by their authority, and the latter by thundering out excommunications " againſt all thoſe, that do act; a courſe, that has a ſtrange influence upon that kind of " people, whoſe ſuperſtition makes them believe a reality of force in thoſe ſcare-crow-thunder- " bolts, that derive all their power only from the people's weakneſs, and are terrible for " nothing, but becauſe they are pleaſed to fear them.

" THIS day with kingly ſtate was buried the great earl of *Eſſex*, having 400 officers, not " one ſo low as a captain, the houſe of peers, the houſe of commons, the city, and the " aſſembly of divines, for his mourners, and all the other parting compliments of honour, that " ever ſubject could aſpire unto. His ſickneſs was an apoplexy, which did not long make " him linger; and thus he, that had eſcaped ſo many mutinies, at laſt periſhed by a mutiny " of the humours. But I have uſually obſerved, that in theſe great funeral ſolemnities, the " pageantry of ſorrow has eaten up the reality; and the care of the blaze diverted men from " mourning. Beſides theſe coſtly flatteries of the dead (with neglect of the poor, whom " that charge might keep alive) ſeem to endeavour to make them guilty of prodigality in " their very graves, whilſt it waſtes that upon a ſenſeleſs carkaſs, that is to it as uſeleſs, as it " is needleſs; whereas it were much better for them to procure the prayers of the living, than " their admiration.

" MY lord of *Inchiquin*'s abſence from *Munſter*, the greater part of this ſummer, by leaving " my brother *Broghill* the ſole command of his army, gave him an opportunity to manifeſt " to the world his gallantry, which he did with an unwonted ſucceſs; and that no leſs con- " ſtant than it was great. But his own wants at home at laſt reduced him to that ſtarving " condition, that when he prayed for his daily bread, his requeſt reached at leaſt as far as his " expectation. He is now there ſoliciting for ſupplies for diſtreſſed *Munſter*, which, though

" very

" very liberally voted, are ſo ſlow in their diſpatch, that many think they have juſt cauſe to " apprehend, that the phyſic will not get thither, before the patient be dead. His actions " have hereby gained him a general eſteem; and he has (if he were not my brother, 'I durſt " ſay deſervedly) acquired the repute of none of the leaſt wits of the time. He and I " within theſe ten days intend, God willing, for the Weſt, in order to his journey to *Munſter*, " whither he is now to carry over, under his own command, a gallant brigade of 4000 effec- " tive foot and 1500 horſe, for the parliament, in that province, till the enſuing ſpring enable " them to tranſport thither a more conſiderable power.

" THE preſbyterian government is at laſt ſettled (though I ſcarce think it will prove long " lived) after the great oppoſition of many, and to their no leſs diſlike; though it ſeemed " very high time unto others, that ſome eſtabliſhed and ſtrict diſcipline ſhould put a reſtraint " upon the ſpreading impoſtures of the ſectaries, which have made this diſtracted city their " general rendezvous, which entertains at this preſent no leſs than 200 ſeveral opinions in " point of religion, ſome digged out of thoſe graves, where the condemning decrees of pri- " mitive councils had long ſince buried them; others newly faſhioned in the forge of their " own brains; but the moſt being new editions of old errors, vented with ſome honourable " title and modern diſguiſements; ſo that certainly if the truth be any where to be found, it " is here ſought ſo many ſeveral ways, that one or other muſt needs light upon it. But others, " that juſtly pretend to a greater moderation, ſuſpect, that our dotage upon our own opini- " ons makes us miſtake many for impoſtures, that are but glimpſes and manifeſtations of " obſcure or formerly concealed truths, or at leaſt our own pride and ſelf-love make us ag- " gravate very venial errors into dangerous and damnable hereſies. The parliament is now " upon an ordinance for the puniſhment of many of theſe ſuppoſed errors; but ſince their " belief of their contrary truths is confeſſedly a work of divine revelation, why a man ſhould " be hanged, becauſe it has not yet pleaſed God to give him his ſpirit, I confeſs, I am yet " to underſtand. Certainly to think by a halter to let new light into the underſtanding, or " by the tortures of the body to heal the errors of the mind, ſeems to me like the applying " a plaiſter to the heel, to cure a wound in the head; which doth not work upon the ſeat of " the diſeaſe.

" MY brother *Brogbill* continues very much your friend, and, I am confident, will be very " ready upon occaſion to realize his profeſſions; and the like I dare boldly affirm of my " ſiſter *Ranelagh*. An employment fit for you we cannot yet procure, becauſe all our no- " bility ſtands at a gaze, to ſee whether the iſſue of the treaties now in debate will be " either peace or war; in either of which caſes it is probable, that a good many of them will " make viſits to foreign climates.

" THE ſadneſs of your condition I very much reſent, and would offer you my aſſiſtance " to ſweeten it, if I did not think the proffer ſuperfluous; but truly I believe it would leſs " afflict you, if you were a ſpectator of our miſeries here, where every day preſents us with " much more unuſual diſpenſations of providence, where I myſelf have been fain to borrow " money of ſervants, to lend it to men of above 10000 l. a year.

" I was yeſterday in company with our *Iriſh* St. *Auſtin*, the archbiſhop of *Armagh*; and " having told him, that you unfolded his myſtery of *the Incarnation* in *French*, he ſeemed very " willing, that you ſhould publiſh it, upon the aſſurance I gave him of the fidelity of its " tranſlation. * * * * * *

" AND now it is high time I ſhould give you ſome account both of myſelf and of my con- " dition; which truly hath been chequered with a great deal of variety of fortune, and a " great many viciſſitudes of plenty and want, danger and ſafety, ſickneſs and health, trouble " and eaſe; wherein I were guilty of an ingratitude great as the favour I have received, if I " did not acknowledge a great deal of mercy in God's diſpenſation towards me; which truly " hath been ſo kind, as oftentimes to work my good out of thoſe things I moſt feared the " conſequences of, and changed thoſe very dangers, which were the object of my apprehen- " ſion, into the motives of my joy. I was once a priſoner here upon ſome groundleſs ſuſpi- " cions, but quickly got off with advantage. The roguery of *Tom. Murray* gave me a great " deal of trouble to diſcover and prevent; but I thence reaped the benefit of making further " diſcoveries into oeconomical knowledge, than ever otherwiſe I ſhould have done. I turned " him away laſt year, to let him know, that I could do my buſineſs very well without him; " but now, having attained to a knowledge of my own ſmall fortune beyond the poſſibility " of being cheated, I am likely to make uſe of him again, to ſhew my father's ſervants, that " I wiſh no hurt to the man, but to the knave.

" I HAVE been forced to obſerve a very great caution, and exact evenneſs in my carriage, " ſince I ſaw you laſt, it being abſolutely neceſſary for the preſervation of a perſon, whom " the unfortunate ſituation of his fortune made obnoxious to the injuries of both parties, " and the protection of neither. Beſides I have been forced to live at a very high rate, " (conſidering the inconſiderableneſs of my incomes) and, to furniſh out theſe expences, " part with a good ſhare of my land, partly to live here like a gentleman, and partly to " perform all that I thought expedient in order to my Iriſh eſtate, out of which I never yet " received the worth of a farthing. * * *

" As for my ſtudies, I have had the opportunity to proſecute them but by fits and ſnatches, " as my leiſure and my occaſions would give me leave. Divers little eſſays, both in verſe and

" proſe,

" profe, I have taken the pains to ſcribble upon ſeveral ſubjects; ſome of the leaſt bad of " which I ſhall venture to ſend you over, as ſoon as my next vacation ſpares me time to lick " them into ſome leſs imperfect ſhape.

" THE *Ethics* hath been a ſtudy, wherein I have of late been very converſant, and deſirous " to call them from the brain down into the breaſt, and from the ſchool to the houſe. I " have endeavoured to make it not only a lanthorn, but a guide, in a juſt, though a brief " treatiſe, that I am writing of it; having already with much trouble in ſome ſixteen chap- " ters travelled through the moſt difficult part of it, and that wherein I ſaw others deficient, " I believe I ſhall leave the reſt to be compleated by thoſe, who enjoy more leiſure.

" THE other humane ſtudies I apply myſelf to, are natural philoſophy, the mechanics, " and huſbandry, according to the principles of our new philoſophical college, that values " no knowledge, but as it hath a tendency to uſe. And therefore I ſhall make it one of my " ſuits to you, that you would take the pains to enquire a little more thoroughly into the " ways of huſbandry, &c. practiſed in your parts; and when you intend for *England*, to " bring along with you what good receipts or choice books of any of theſe ſubjects you can " procure; which will make you extremely welcome to our *inviſible college*, which I had " now deſigned to give you a deſcription of, but a gentleman, whom I have been forced to " keep talk with all the while I was writing this, together with the fear of having too much " already treſpaſſed upon your patience, call upon me to end your trouble and this letter " together."

HE was likewiſe at *London* in February 1646-7, whence he wrote the following letter, dated the 20th of that month, to Mr. *Francis Tallents*, then fellow of *Magdalen* college in *Cambridge*.

SIR,

" I SHOULD venture to apologize for my ſilence, if I thought it not leſs guilty than " meritorious; ſince to reprieve you from the importunity of my letter, I have hitherto " denied myſelf that happineſs, that your civility makes me confident I might have enjoyed " by the receiving of yours. I have been every day theſe two months upon viſiting my own " ruined cottage in the country; but it is ſuch a labyrinth this *London*, that all my diligence " could never yet find the way out on't, and hath but juſt now put me in a probability of " leaving it within theſe two or three days. The beſt on't is, that the corner-ſtones of the " *inviſible*, or (as they term themſelves) the *philoſophical college*, do now and then honour me " with their company, which makes me as ſorry for thoſe preſſing occaſions, that urge my " departure, as I am at other times angry with that ſolicitous idleneſs, that I am neceſſitated " to during my ſtay; men of ſo capacious and ſearching ſpirits, that ſchool-philoſophy is " but the loweſt region of their knowledge; and yet, though ambitious to lead the way to " any generous deſign, of ſo humble and teachable a genius, as they diſdain not to be di- " rected to the meaneſt, ſo he can but plead reaſon for his opinion; perſons, that endea- " vour to put narrow-mindedneſs out of countenance, by the practice of ſo extenſive a charity, " that it reaches unto every thing called man, and nothing leſs than an univerſal good-will " can content it. And indeed they are ſo apprehenſive of the want of good employment, " that they take the whole body of mankind for their care.

" BUT leſt my ſeeming hyperbolical expreſſions ſhould more prejudice my reputation than " it is able any ways to advantage theirs, and I be thought a liar for telling ſo much truth, " I will conclude their praiſes with the recital of their chiefeſt fault, which is very incident " to almoſt all good things; and that is, that there is not enough of them.

" FOR news, I believe you do not ignore, what a ſtream of ſucceſs the parliament, ſince " I had the honour to ſee you, has had. I will only now take the freedom to tell you, that " I am greatly afraid, moſt men flatter themſelves in their prognoſtications of peace, which " are calculated rather to the meridian of their deſires, than to that of their reaſon. And " though I muſt confeſs, the traveller ſeems to be very near the inn, yet I know not why " the horſe may not ſtumble at the threſhold; for I am ſomewhat unapt to perſuade myſelf, " that the judgment will ceaſe, while the cauſe continues; but am rather very ready to ap- " prehend, that while adverſity makes ſome obſtinate, and others wanton, though the war " perhaps may die, the judgment will be kept alive. The pulpits were never more adorned " with excellent divines, than they now are here, but with ſo unſuitable a ſucceſs in many " of the people, that I can ſometimes think it no breach of charity to believe, that the " ſmall-pox has ſtricken inward, and many of them have but baniſhed their vices from the " body into the heart. For my part, the excellency of the miniſtry, ſince waited on by " ſuch an improficiency, increaſes my preſaging fears of the approaching miſery of the peo- " ple; for I ſhall eaſily be drawn to ſuſpect that horſe to be very ſick, that thrives not in ſo " plentiful a paſture. And truly, methinks, it is but a very ſad ſymptom, when the phyſic " augments the diſeaſe. For matter of ſects, it ſeems, that moſt of thoſe at *Amſterdam* have " been returned us over by bill of exchange, which our Engliſh ſearchers have been ſo in- " duſtrious to improve, that there are few days paſs here, that may not juſtly be accuſed of " the brewing or broaching of ſome new opinion. Nay, ſome are ſo ſtudiouſly changling " in that particular, they eſteem an opinion as a diurnal, after a day or two ſcarce worth

" the keeping. If any man have loſt his religion, let him repair to *London*, and I'll warrant " him, he ſhall find it: I had almoſt ſaid too, and if any man has a religion, let him but come " hither now, and he ſhall go near to loſe it. Pray God, it fare not with religion amongſt " thoſe novelties, as it does ſometimes with a great commander, when he is taken priſoner " by a company of common ſoldiers, who every one tugging to have him for himſelf, at laſt " pull him to pieces, and ſo each get a limb, but none enjoys him whole. For my part, I ſhall " always pray to God to give us *the unity of the ſpirit in the bond of peace*, and deſire you " to believe, that, amongſt all the apoſtaſies of the time, I ſhall be the leaſt capable of being " ſeduced by that, that may oppoſe my being and continuing ſo,

Your moſt affectionate friend and faithful ſervant,

ROBERT BOYLE.

MR. *Tallents*, to whom this letter was written, had been, while he was an under-graduate, ſub-tutor to ſeveral ſons of the earl of *Suffolk* (one of whoſe daughters was married to lord *Broghill*,) being removed from *Peter* houſe to *Magdalen* college for that purpoſe; and about the year 1642 travelled abroad with them as their tutor. After his return, he became ſenior fellow and preſident or vice-maſter of his college; and having ſpent near twenty years in the univerſity, was ſettled of St. *Mary*'s in *Shrewſbury*, whence he was ejected for nonconformity in 1662. In the year 1670 he went a ſecond time as tutor to two young gentlemen, Mr. *Boſcawen* and Mr. *Hamden*. In the laſt part of his life he was paſtor to a congregation of proteſtant diſſenters at *Shrewſbury*, where he died April 11th, 1708, in the 89th year of his age. He was author of the Chronological Tables [a].

MR. *Boyle* returned to *Stalbridge* ſoon after his writing the abovementioned letter to Mr. *Tallents*, as appears from one to his ſiſter, the lady *Ranelagh*, dated there Feb. 27, 1646-7, in which he writes as follows:

" * * * As to my *Dublin* buſineſs, I muſt expect from your ſpeedy information (I now " beg of you) of their names, to whom the parliament has given power to oblige me there, " directions both how to frame, and to whom to addreſs my requeſt. I muſt acknowledge " to you, amongſt God's mercies of the firſt magnitude, both my lord of *Ormonde*'s unex- " pected coming in, and the parliament's leſs expected diſpatch; though both very conſo- " nant to the wonted method of that gracious providence, that we find then oftentimes the " neareſt for our reſcue, when that is furtheſt from our expectations. For my part, I am bold " to believe, had we no other arguments to prove a providence, yet the ſtrange revolutions, " of which in ſo ſhort a time our ruined country has been the unhappy ſcene, were more " than ſufficient to demonſtrate that truth, to which alone I ſhall allow a greater infallibility, " than to that other moſt certain one of my being,

Siſter, your moſt truly affectionate

brother and humbleſt ſervant,

ROBERT BOYLE.

HIS next letter, dated from the ſame place, March 6, 1646-7, ſhews, that he was then entering upon his chemical ſtudies.

" * * * THAT great earthen furnace, ſays he, whoſe conveying hither has taken up ſo " much of my care, and concerning which I made bold very lately to trouble you, ſince " I laſt did ſo, has been brought to my hands crumbled into as many pieces, as we into ſects; " and all the fine experiments, and caſtles in the air, I had built upon its ſafe arrival, have " felt the fate of their foundation. Well, I ſee I am not deſigned to the finding out the " philoſophers ſtone, I have been ſo unlucky in my firſt attempts in chemiſtry. My limbecks, " recipients, and other glaſſes have eſcaped indeed the misfortune of their incendiary, but " are now, through the miſcarriage of that grand implement of *Vulcan*, as uſeleſs to me, " as good parts to ſalvation without the fire of zeal. Seriouſly, madam, after all the pains " I have taken, and the precautions I have uſed, to prevent this furnace the diſaſter of its " predeceſſors, to have it tranſported a thouſand miles by land, that I may after all this " receive it broken, is a defeat, that nothing could recompence, but that rare leſſon it teaches " me, how brittle that happineſs is, that we build upon earth."

HIS acquaintance with Mr. *Samuel Hartlib* began very early. The father of that gentleman was a very conſiderable merchant in *Poland*, but obliged, on account of his attachment to the proteſtant religion to retire to *Elbing* in *Pruſſia*. His two firſt wives were Poliſh ladies, of noble extraction, and his third, the mother of Mr. *Samuel Hartlib*, had two ſiſters, both of whom were very honourably married, one to Mr. *Clarke*, the ſon of a lord mayor of *London*, afterwards to Sir *Richard Smith*, a privy counſellor, and at laſt to Sir *Edward Savage*; and the

[a] See his character by Mr. *Matthew Henry* ſubjoined to his *Funeral Sermon*.

other to Mr. *Peake*, a younger brother of a good family [a]. Mr. *Hartlib*, Mr. *Boyle*'s friend, came to *England* about the year 1630, and ſoon diſtinguiſhed himſelf by his great zeal for the improvement of natural knowledge, and making it uſeful to human life. For which purpoſe, beſides what notices he could procure at home, he entertained a conſtant correſpondence with the virtuoſi in moſt other parts of *Europe*; and *Milton*, in his *Tractate of Education*, which he addreſſed to him, ſpeaks of him, as "a perſon ſent hither by ſome good provi-"dence from a far country, to be the occaſion and the incitement of great good to this "iſland." He obſerves likewiſe himſelf in his letter to Dr. *Worthington* abovecited, that "as "long as he had lived in *England*, he had ſpent yearly out of his own betwixt three and four "hundred pounds ſterling. And when, ſays he, I was brought to publick allowance, I have "had from the parliaments and councils of ſtate a penſion of three hundred pounds ſterling a "year, which as freely I have ſpent for their ſervice and the good of many." But notwithſtanding the eminent advantages, which the public had reaped from his writings, and the aſſiſtances he had given to thoſe of other men, he was reduced, after the Reſtoration, to very neceſſitous circumſtances, as appears from the letters of Dr. *Worthington* to him, publiſhed at the end of that divine's *Miſcellanies*, and from a petition [b] of Mr. *Hartlib* to the houſe of commons, that "he might find from their goodneſs and bounty ſome relief in his diſtreſſed "condition, by being freed from his debts, and put in a capacity to continue his ſervice to "the public, to advance in his generation the beſt objects for the uſe of mankind in all kinds." The firſt letter I find of Mr. *Boyle* to him was dated from *Stalbridge*, March 19, 1646-7.

"Dear Mr. *Hartlib*,

"I NEED a great deal of rhetoric to expreſs to you, how great a ſatisfaction I received "in the favour of your letter, both for the ſake of the theme, and more for that of the "author. But my contentment was greatly qualified by the miſcarriage of the general "writing (which ſhould be ſtiled the Univerſal Truchman, or General Interpreter, if I were "to be godfather) you were pleaſed to ſend me; for the commendations you give it are too "great not to make me very ſenſible of its loſs. If the deſign of *the Real Character* [c] take "effect, it will in good part make amends to mankind for what their pride loſt them at the "tower of *Babel*. And truly, ſince our arithmetical characters are underſtood by all the na-"tions of *Europe* the ſame way, though every ſeveral people expreſs that comprehenſion "with its own particular language, I conceive no impoſſibility, that oppoſes the doing that "in words, that we ſee already done in numbers. As for the pneumatical engine, that I uſe "to call a wind-gun, which you mention in your letter as preſented to the king, and for-"bidden by him to have any companions, ſure the artiſt, that received the command, was "more ingenious than obedient; for I remember very well to have ſeen one of them not "exceeding in bigneſs, nor differing much in ſhape from an ordinary carabine, which being "charged by the ſole impreſſion of the air, would, by violence of the contracted Boreas, ſend "forth a leaden bullet, juſt the caliber, with force to kill a man at twenty five or thirty paces "diſtance from him. This wind-gun I ſaw both charged and diſcharged; and now it comes "into my mind, I read, not long ſince, in a late mechanical treatiſe of the excellent *Merſennus*, "both the conſtruction and the uſe of this engine; and amongſt the uſes one, whoſe ſtrata-"gem obliged me to take of it particular notice; and it was, how by the help of this inſtru-"ment to diſcover the weight of the air; which, for all the prattling of our book-philoſophers, "we muſt believe to be both heavy and ponderable, if we will not refuſe belief to our ſenſes. "Your *Imago Societatis*, and your *Dextera Amoris*, I have great longings to peruſe; and though "with a deep ſenſe of my inſufficiency, I ſhall very freely expreſs my obedience in deliver-"ing the opinion of

"Your humble ſervant,

"ROBERT BOYLE.

THE next letter extant to that gentleman is of the 8th of April, 1647.

"Dear Mr. *Hartlib*,

"I HOPE I ſhall need none other apologies for my laſt week's ſilence, than my abſence "hence, when your letters arrived here. Your *Imago Societatis* with a great deal of delight "I have peruſed, but muſt beg ſome leiſure to acquaint you with my opinion of it, which "now were almoſt impoſſible for me to do, I having already preſented it to a perſon of quality, "with whom if it take ſuitably to my wiſhes, it may thence have no obſcure influence upon "the public good, concerning which I have lately traced a little dialogue in my thoughts, "which my unceaſing domeſtic diſtractions will by no means as yet permit me to blot paper "with. The epiſtle prefixed to the *Imago* is both pithy and to the purpoſe. And truly I am "extremely glad to ſee a perſon of Mr. *Hall*'s years employ, in attempts of this nature, that

[a] Mr. *Samuel Hartlib*'s letter to Dr. *John Worthington*, Aug. 3, 1660, communicated by Mr. *John Ward*, profeſſor of rhetoric in *Greſham* college.

[b] Communicated by Mr. *Ward*.

[c] This ſeems to relate to an excellent deſign, which was afterwards executed by Dr. *John Wilkins*, and publiſhed at *London*, 1668, in folio, under the title of *An Eſſay towards a Real Character, and a Philoſophical Language*.

"youth,

" youth, which the moſt of thoſe, that are as little indebted to time as he, think too good for " their Maker, though they think it not too good to be ſquandered away. *Campanella*'s " *Civitas Solis* [a], and that ſame *Reſpublica Chriſtianopolitana*, which he mentions, will both of " them deſerve to be taught in our language. Of the *Utopia* he is modelling, though I cannot " judge, before it ſees the light, yet my expectations will be none of the ſmalleſt, if I pro- " portion them to the ingenuity of the author. And for the Divine Emblems, that he makes " us hope for, I muſt reſerve my ſenſe of them for their peruſal, ſince the opinions I embrace, " both about the nature and the teaching of virtue, will doubtleſs appear as paradoxical to " others, as they ſeem probable to me. For thoſe deſigns of Mr. *Hall*'s Tutor, which you " have ſo appropriatingly chriſtened, I believe the requeſts of the excommunicated petition " now on foot in the army will ſcarce receive a ſlower ſatisfaction; for the particulars, in which " he requires it, do not only aſk a profound knowledge and ſolid judgment (qualities of " themſelves not very epidemical) but likewiſe a leiſured and a great multiplicity of reading, " and ſo an intimacy as well with authors as with things; qualities, that in this ſtirring and " neceſſitous age (where men are forced to court don *Plutus* and my lady *Fortune* with more " aſſiduity than the Muſes) make very unfrequent matches in the ſelf-ſame perſon: beſides " that the diſſenting opinions of the *Ptolemeans*, the *Tychonians*, the *Copernicans*, (to which I " was once very much inclined,) and the other noveliſts, are both ſo irreconcilable among " themſelves, and leave a man ſo little latitude of neutrality, that it will be perhaps but one " remove from impoſſible, preciſely to declare, what has been hitherto both perfectly de- " monſtrated and confeſſedly on all ſides; the one taking that (as I have known by experience, " when I ſtudied that problem of the earth's peregrination) for an undeniable demonſtration, " which the other will either abſolutely reject as a paralogiſm, or at leaſt call in queſtion, " as no more than a bare probability.

" YOUR *Common Writing* (for which you have my humble thanks) is at laſt come ſafe to " my hands; but my occaſions have not yet allowed the leiſure to fix my thoughts upon it: " only if the dictionary (whoſe edition, had my wiſhes the power, to ſwiften it, ſhould be " very ſudden) do not over-ſwell and diſeaſe it of a tympany, methinks the bulk of the " grammar is very reaſonable in reference to what the title promiſes, which I was well pleaſed " to ſee ſo, apprehending (nor are my fears yet entirely ſuppreſſed) leſt that this way of " ſaving the labour of learning a language ſhould prove like a new device, I have lately " ſeen, to perform all the operations of arithmetic by the help of an inſtrument, where I " found it much more difficult to learn the uſes of the inſtrument, than the rules of the art.

" THAT in my laſt I took no notice of Mr. *Dury*'s excellent diſcourſe of teaching logic, " was not at all my neglect, but the treacherouſneſs of my memory; for which meaning to " apologiſe to the author himſelf, I ſhall for this time add no more to your trouble, but an " humble requeſt to aſſure him, that I am his, and yourſelf, that I am

" Your moſt really affectionate friend and humble ſervant,

" ROBERT BOYLE.

THE letter, which he wrote on the 3d of *May*, 1647, to Mr. *John Dury*, famous for his attempts to reconcile the Lutherans and Calviniſts, will ſhew Mr. *Boyle*'s moderation, at that time, with reſpect to differences in religious opinions.

" IT has been long, ſays he, as well my wonder, as my grief, to ſee ſuch comparatively " petty differences in judgment make ſuch wide breaches and vaſt diviſions in affection. " It is ſtrange, that men ſhould rather be quarrelling for a few trifling opinions, wherein they " diſſent, than to embrace one another for thoſe many fundamental truths, wherein they " agree. For my own part, in ſome two or three and forty months, that I ſpent in the very " town of *Geneva*, as I never found that people diſcontented with their own church-govern- " ment (the gallingneſs of whoſe yoke is the grand ſcare-crow, that frights us here;) ſo could " I never obſerve in it any ſuch tranſcendent excellency, as could oblige me either to bolt " heaven againſt, or open *Newgate* for all thoſe, that believe they may be ſaved under " another. Wherefore I muſt confeſs, it would be extremely my ſatisfaction, if I could ſee, " by God's bleſſing, your pious endeavours of twiſting our froward parties into a moderate " and ſatisfactory reconcilement, as ſucceſsful, as I am confident they will be prudent and " unwearied. As for our upſtart ſectaries (muſhrooms of the laſt night's ſpringing up) the " worſt part of them, if not exaſperated by, inſtead of lighting them into the right way " with the candle, flinging the candleſtick at their heads, like *Jonah*'s gourd, ſmitten at the " root with the worm of their irrationality, will be as ſudden in their decay, as they were " haſty in their growth; and indeed perhaps the ſafeſt way to deſtroy them is rather to let " them die, than attempt to kill them."

ON the 8th of the ſame month he wrote the following letter to Mr. *Hartlib*.

[a] This piece contains the idea of a commonwealth, after the manner of Sir *Thomas More*'s *Utopia*, and is printed with *Campanella*'s *Realis Philoſophiæ Epilogiſticæ partes quatuor*, at *Francfort*, 1623, in 4to.

" Dear

" Dear Mr. *Hartlib*,

" IT was very needleſs in your laſt to make apologies for the glad parliamentary news you " began your letter with; for beſides that its goodneſs authoriſes its nature, and were able " to prefer ſo pleaſing a diſobedience to the moſt exact compliance with my deſires; beſides " this, I ſay, you intereſt yourſelf ſo much in the *Inviſible College*, and that whole ſociety is " ſo highly concerned in all the accidents of your life, that you can ſend me no intelligence " of your own affairs, that does not (at leaſt relationally) aſſume the nature of *Utopian*. " And truly, Sir, for my particular, had you been to coin and ſhape news, not ſo much to " inform, as to delight me, you could ſcarce have made choice of any, that were more " welcome, either to my wiſhes for their own particular ſatisfaction, or for thoſe, that I dedicate " to the good of the public, which can acknowledge your merits with no advantage, that " has not a direct tendency to its own, and which, by the higheſt expreſſions of gratitude " for your ſervice to it, does but enable your zeal to multiply and continue them. The " phraſes of the ordinances (which theſe alone of yours have brought me into charity with " again) were indeed extremely civil in reſpect of thoſe, that framed them; and yet but " barely juſt in regard of him, for whom they were deſigned. Certainly the taking notice " of, and countenancing men of rare induſtry and publick ſpirit, is a piece of policy as vaſtly " advantageous to all ſtates, as it is ruinouſly neglected by the moſt. And therefore we may " evidently obſerve thoſe commonwealths (as the *Hollanders* and the *Venetian*) to be the moſt " happy and the moſt flouriſhing, where ingenuity is courted with the greateſt encourage- " ments. Mr. *Hall*'s unmerited elogium of me I muſt in juſtice aſcribe rather to his civility, " than to his opinion; to the former of which I am alſo redevable for a very handſom com- " plimental letter, he was lately pleaſed to honour me with, to which I ſhall requeſt a ſpeedy " conveyance of the incloſed (though unſuitable) anſwer, and a belief, that I liſt it not " amongſt the leaſt of your favours, to procure me the acquaintance of a perſon, that treading " antipodes to the ſtrain of his contemporaries, has September in his judgment, whilſt we " can ſcarce find April upon his chin.

" MY ſenſe of his propoſitions concerning the College I muſt neceſſarily ſuſpend, till a more " exquiſite information of the particulars of his whole deſign. Only by the by I ſhall take " the freedom to tell you, that though I eſteem Mr. *Hall* very moderate in the point of pe- " cuniary duties, you can ſcarce be too tender in taſking young collegiates as to the duties of " the brain, ſince they being all of them to be perſons of quality and voluntiers, will hardly " ſupport with alacrity any thing, that ſavours of conſtraint; beſides that the gallantry and " nobleneſs of their own principles will carry them on unimpoſedly to do much more, than " your ſtricteſt conſtitutions can reaſonably enjoin them. The expedients you propoſe to " Mr. *Hall*'s tutor are not at all unlikely to take; and the applications you counſel him to " make to thoſe three famous mathematicians, can promiſe a great deal of probability for " their ſucceſs: eſpecially *Gaſſendus*, a great favourite of mine, I take to be a very profound " mathematician, as well as an excellent aſtronomer, and one, that has collected a very ample " treaſury of numerous and accurate obſervations of all, that belongs to the abſtruſe ſcience " of thoſe ſublimer bodies. I find you very happy, or rather very judicious, in the nominating " of the perſons, Mr. *Hall*'s tutor is by you addreſſed to; and am confident, as well as you, " that thoſe elevated ſpirits will not prove half ſo coſtive and ſo pedantical, as the great " ſcholarians of our colleges, whom yet I am apt enough to pardon, in conſideration of the " uſefulneſs (for the moſt part) of the knowledge they conceal, which perhaps being ad- " mired but as long as kept in a myſtery, an imparting diſcovery would depreciate.

" THE riſe you have now to reſume your former correſpondencies with the great *Mer-* " *ſennus*, I hope you will greedily embrace, he being a man truly incomparable in his own " way, and the mechanics he tranſcends in as greatly beneficial as little underſtood. The " Engliſhing of, and additions to *Oughtred*'s *Clavis Mathematica* does much content me, I " having formerly ſpent much ſtudy on the original of that algebra, which I have long ſince " eſteemed a much more inſtructive way of logic, than that of *Ariſtotle*. No body has yet " been charitable enough to ſend me either the long deſired *Office of Addreſs*, or Mr. *Dury*'s " wiſhed for diſcourſe concerning Accommodation, though my longings for their ſight have " been very ſuitable to the contentments I expect from their peruſal. I have written a long " letter to Mr. *Dury*, by the ſame poſt, that is to deliver you this; and it ſhall not be the " neglect of my improving my rhetoric to the uttermoſt, that ſhall impede my prevailing " with him, by exemplifying his rules, to clothe with fleſh and ſkin his excellent ſceleton " of the Art of Reaſoning.

" FOR your bedfellow's receipt for the ſtone (which certainly wants a parallel, if it be not " more eaſy than effectual) I beſeech you to return her (together with the preſent of my " humble ſervice) moſt humble thanks, which I mean very ſhortly, God willing, to pay " you in an epiſtle I have drawn up to perſuade men to communicate all thoſe ſucceſsful " receipts, that relate either to the preſervation or recovery of our health; to which (if you " will pardon me a clinch) I ſhall add, as to the diſeaſe laſt named (ſo cruel in its tor- " tures, and ſo fatal in its cataſtrophe) that they muſt have their hearts more hard than " a very ſtone, that can refuſe a ſanative remedy for the ſtone.

" As for me, during my confinement to this melancholy ſolitude, I often divert myſelf " at leiſure moments in trying ſuch experiments, as the unfurniſhedneſs of the place, and " the preſent diſtractedneſs of my mind, will permit me; which when once my vacant " intervals of time will give me leave to blot paper with, and make ſome ſhort diſcourſes and " reflections upon, you may (with all the ſervices you ſhall be pleaſed to command their " author) confidently expect from,

" Sir, your moſt affectionate friend and humble ſervant,

" ROBERT BOYLE.

THE *Inviſible College*, which Mr. *Boyle* ſpeaks of in this letter, as well as in thoſe to Mr. *Marcombes* and Mr. *Tallents*, probably refers to that aſſembly of learned and curious gentlemen, who, after the breaking out of the civil wars, in order to divert themſelves from thoſe melancholy ſcenes, applied themſelves to experimental inquiries, and the ſtudy of nature, which was then called the new philoſophy, and at length gave birth to the Royal Society. This aſſembly Dr. *Wallis*, who was one of its members, gives the following account of *. " About the year 1645, (ſays he) while I lived in *London*, I had the opportunity to " be acquainted with divers worthy perſons, inquiſitive into natural philoſophy and other " parts of human learning, and particularly of what hath been called the new or experimen- " tal philoſophy. We did by agreement, divers of us, meet weekly on a certain day, to " treat and diſcourſe of ſuch affairs. Of which number were Dr. *John Wilkins*, afterwards " biſhop of *Cheſter*, Dr. *Jonathan Goddard*, Dr. *George Ent*, Dr. *Gliſſon*, Dr. *Merret*, doctors " in phyſic; Mr. *Samuel Foſter*, then profeſſor of aſtronomy at *Greſham* college, Mr. *Theodore* " *Haak*, a German of the Palatinate, and then reſident in *London*, who, I think, gave the " firſt occaſion, and firſt ſuggeſted thoſe meetings, and many others. Theſe meetings we " held ſometimes at Dr. *Goddard*'s lodging in *Wood-ſtreet* (or ſome convenient place near) " on occaſion of his keeping an operator in his houſe, for grinding glaſſes for teleſcopes and " microſcopes; and ſometimes at a convenient place in *Cheapſide*; ſometimes at *Greſham* " college, or ſome place near adjoining. Our buſineſs was (precluding matters of theology " and ſtate-affairs) to diſcourſe and conſider of philoſophical inquiries, and ſuch as related " thereunto, as phyſic, anatomy, geometry, aſtronomy, navigation, ſtatics, magnetics, " chemics, mechanics, and natural experiments, with the ſtate of theſe ſtudies, as then cul- " tivated at home and abroad. About the year 1648, 1649, ſome of us being removed to " *Oxford*, firſt Dr. *Wilkins*, then I, and ſoon after Dr. *Goddard*, our company divided. Thoſe " in *London* continued to meet there, as before, and we with them, when we had occaſion to " be there. And thoſe of us at *Oxford*, with Dr. *Ward*, ſince biſhop of *Saliſbury*, Dr. *Ralph* " *Bathurſt*, now preſident of *Trinity* college in *Oxford*, Dr. *Petty*, ſince Sir *William Petty*, " Dr. *Willis*, then an eminent phyſician in *Oxford*, and divers others, continued ſuch meetings " in *Oxford*, and brought thoſe ſtudies into faſhion there, meeting firſt at Dr. *Petty*'s lodgings " in an apothecary's houſe, becauſe of the convenience of inſpecting drugs, and the like, as " there was occaſion; and after his remove to *Ireland* (though not ſo conſtantly) at the lodg- " ings of Dr. *Wilkins*, then warden of *Wadham* college; and after his removal to *Trinity* " college in *Cambridge*, at the lodgings of the honourable Mr. *Robert Boyle*, then reſident for " divers years in *Oxford*. Theſe meetings in *London* continued, and after the King's return, " in 1660, were increaſed with the acceſſion of divers worthy and honourable perſons, and " were afterwards incorporated by the name of the *Royal Society*, and ſo continue to this " day."

BUT to return to Mr. *Boyle*, his early zeal for religion and virtue, and his friendly faithfulneſs in reproving and counſelling ſuch as tranſgreſſed the laws of both, are evident from two letters ſent to a noble lord, one or both written, when he was but little turned of twenty years of age, I ſhall ſubjoin one of them.

" Dear Count,

" WHEN I ſhould have anſwered yours by the laſt poſt, ſome phyſic I had taken " the night before ranging very briſkly through all my veins had ſo ſtirred up and " exaſperated my ill humours, that I durſt not handle a pen. But now I am calmed enough " to let you know, that I leſs applaud your conſtancy than your gallantry, that makes you ſo " unſeaſonably turn Preſbyterian, by devoting yourſelf to the *Kirk*. I hope you will never " juſtify the proverb of, *the nearer the Church, the farther from God*; but this ſame epithet of " *incomparable*, with the appertaining ſtory, if it be not rather your compliment, than your " opinion, reliſhes of more paſſion, than is allowed you for any woman but one. If I durſt ſo " much injure your judgment, as to diſtruſt your conſtancy, I ſhould tell you, that marriage " is not a bare preſent, but a legal exchange of hearts; and the ſame contract, that gives you " right to another's, ties you to look upon your own as another's goods, and too ſurely

* See his letter to Dr. *Thomas Smith*, dated January 29, 1696-7, publiſhed in Mr. *Thomas Hearne*'s Appendix to his preface to *Peter Langtoft*'s chronicle, Vol. I. p. 161. edit. *London*, 1725.

" made over, to remain any longer in your gift. I ſhould tell you farther, that no change " could be leſs excuſable than yours, not only becauſe you are bleſſed with a lady, whoſe " beauty and merit make injuries to your faith and happineſs inſeparable, but becauſe too " you cannot father upon your obedience any temptation to a ranging flame; for you aſſum- " ed the entire liberty of chuſing to yourſelf whom you muſt now ſolely blame, if you " matched not to your ſatisfaction, when you matched ſo purely for it, that had you as much " motive to fickleneſs, as you have to the contrary virtue, you ought to expect as little " pity, as, God be praiſed, you need; and could betray no diſlike of your election, that " would not either criminate your honour, or diſparage your judgment. * * *

" BUT I hope, dear count, by this time you will think me as mad for writing all this " to you ſeriouſly, as I ſhould think you, if my ſuſpicions were juſt; for I hope your inno- " cence will turn all this into a compliment to Mrs. *Kirke*, by diſtruſting her eyes of the " power of kindling a flame, which ſuch obſtacles oppoſe, and ſo great inconveniences " would attend.

" THE diſaſter of your addreſſes to the council of ſtate I am extremely troubled at, both " for your ſake and my own; ſince not only that diſappointment defeats me of good com- " pany, but, I much fear, miſleads you into ill. And truly, my lord, I am enough your " ſervant to tell you freely, that a young man, that ventures himſelf in ill company, tempts " as many temptations, and expoſes himſelf to as many inconveniences, as to reckon up would " require a homily, and to inſiſt on a volume, rather than a letter. The ſeveral goods of " body, mind, fame, and fortune, are blaſted by ill company. For firſt (to begin with the " laſt) it engages us to that riot and expenſiveneſs, which, beſides that it is ever ruinous, is " now ſignally unſeaſonable, being not only extremely unſuitable to the ſad condition of our " times, but peculiarly obſtructive to thoſe, who make applications to the ſtate for relief or " compenſation of loſſes; ſince the ſame expences, that beget want, paſs for arguments of " plenty, in the opinion of thoſe, whoſe belief of our want is as great a requiſite to the re- " moval of it, as the juſtneſs of that belief were a misfortune. How much the body ſuffers " by thoſe debauches, that are epidemical to looſe company, though the inſtances be nume- " rous and obvious, few youths will believe, till their experience hath ſadly convinced them; " not to mention, that thoſe diſtempers, that are both the effects and puniſhments of exceſs, " are as uneaſy upon the ſcore of ſhame, as that of pain; and health impaired by diſſolute- " neſs has commonly the fate of needing pity, and wanting it. As for the mind, *ill* com- " pany is an infected air for it; which, though it be preciſely no diſeaſe, diſpoſes to the moſt " mortal ones. Bad examples are the general pimps of every vice; and I dare boldly affirm, " that fewer people go to hell for pride, or oaths, or incontinency, than for company; which " I therefore deſire to draw in blacker colours to you, becauſe I have ever obſerved it worſt " for the beſt natures, ſince they being pliable and eaſy do many things, that offend their " conſciences, merely to pleaſe the company, which a man muſt be like to be liked, and " which not to imitate is interpreted to reprove. And when once compliance has betrayed " one to a vice, cuſtom detains us there, it happening to men in ſins, as in taking of tobacco, " which, though at firſt ſucked in with reluctance, barely to pleaſe the company, men after- " wards find a guſto in, and are unable to leave off. And therefore I prefer few laws before " that of a nation we are pleaſed to call barbarous, amongſt whom it was allowed to ſue a " man for keeping evil company, as well as for riot, adultery, or any other crime it leads to; " which will appear leſs ſtrange and more equitable to them, that conſider, that amongſt us " a bawd is as legally puniſhable as a whore or wenching. And laſtly, a good name can by " nothing be ſtrained deeplier than by ill company. Few people have either the charity or " opportunity to know men intimately; and there is no way either more probable, or more " frequented, to judge of thoſe we know not, than by their company, ſince men are not " unreaſonably ſuppoſed to delight in thoſe qualities they delight in others for. For beſides " that the choice of ill company does not only make men thought to have been vicious, but " to be made ſo, as longing for unhealthy and extravagant traſh does not only argue, that " a maid has the green-ſickneſs, but ſerves to increaſe the diſeaſe; young men conſider not " enough, how deep a root the firſt impreſſions they give of themſelves take, and conſider " not, how difficult it is to bring men to think well, when to do ſo they muſt acknowledge " to themſelves, that they have thought amiſs; eſpecially ſince moſt human acknowledg- " ments being of ſo changeable-coloured a complexion, that like pigeons necks they give " various repreſentations, as they are variouſly looked on. A diſfavouring prepoſſeſſion brings " even our good actions under the diſadvantage of ſuſpicion, and procures our indifferent ones " the harſheſt conſtruction; where the intention is doubtful, men generally collecting it from " their opinion of the perſon, and being diſpoſed to believe rather, that he is faulty, than " they miſtaken."

IT was about the ſame time, that he wrote his *Free Diſcourſe againſt cuſtomary Swearing*; the manuſcript of which in his own hand-writing is ſtill extant; and by the neatneſs and exactneſs of it appears not to have been the firſt draught, though it is dated *Anno MDCXLVII.* The firſt leaf has this title, *The Swearer ſilenced by* R. B. but in the firſt page it is called, *A Free Diſcourſe againſt cuſtomary Swearing.* It is dedicated to his ſiſter, the counteſs of *Kildare.* There is annexed to it, *A Diſſuaſive from curſing, from Mr.* W. D. *to Sir* G. L. Theſe two

pieces were publiſhed at *London*, 1695, in 8vo, by Dr. *John Williams*, afterwards biſhop of *Chicheſter*, who obſerves in his preface, that the *Diſcourſe* was the third treatiſe, which Mr. *Boyle*, though then but twenty years of age, had prepared for the public; his *Seraphic Love*, afterwards printed, and his *Eſſay on miſtaken Modeſty*, being referred to in this piece.

BUT the courſe of his ſtudies was interrupted for ſome time in the ſummer of the year 1647, by a ſevere fit of the ſtone, to which diſtemper he was extremely ſubject. However in September following he went to *Briſtol* and *Saliſbury*; and in *February*, 1647-8, made a voyage to *Holland*, partly to viſit the country, and partly to accompany his brother *Francis* in conducting his wife from the *Hague* [a]. But he did not ſtay long there, for on the 15th of April, 1648, he was at *London*; and on the 13th of May at *Stalbridge*, whence he wrote to his ſiſter *Ranelagh*, giving her an account, that he ſhould poſſibly ſoon ſend her his thoughts upon the ſubject of *Toleration*, in an eſſay of his, intitled, *Of Divinity* [b]. He returned to *London* the ſame month, where he was likewiſe in July; and in a letter to the counteſs of *Monmouth* at *Moor-Park*, dated the 7th of that month, mentions a piece of his writing, then in the hands of that lady [c]. He was in Auguſt following at *Leez* in *Eſſex*, the ſeat of his ſiſter the counteſs of *Warwick*, where on the 6th of that month he finiſhed his treatiſe, intitled, *Some Motives and Incentives to the Love of God, pathetically diſcourſed of in a Letter to a Friend:* of which I ſhall give ſome further account below, when I have occaſion to mention the publication of it. But he was returned to *Stalbridge* on the 9th of *September* following; and on the 26th of March 1649, was at *Marſton* in *Somerſetſhire*, the ſeat of his brother, the lord *Broghill*; and on the 2d of Auguſt at *Bath*; in a letter from whence to his ſiſter *Ranelagh* of that date [d], he takes notice of his having been troubled for three or four weeks with a quotidian ague, "though in the intervals of the fit (ſays he) I both began and made ſome progreſs "in the promiſed diſcourſe of *Public Spiritedneſs*. But now truly weakneſs, and the doctor's "preſcriptions, have caſt my pen into the fire, though in ſpite of their menaces I ſometimes "preſume to ſnatch it out a while, and blot ſome paper with it. My preſent employment "is reviewing ſome *Conſolatory Thoughts on the Loſs of Friends*, which my poor lady *Suſan*'s "death obliged me to entertain my ſelf with, and which I am now recruiting." But on the 31ſt of that month he was returned to *Stalbridge*, as appears from a letter of his of that date to the ſame lady [e], wherein he writes thus: "I will not now preſume to entertain you "with thoſe moral ſpeculations, with which my chemical practices have entertained me; "but if this laſt ſickneſs had not diverted me, I had before this preſented you with a diſ-"courſe (which my vanity made me hope would not have diſpleaſed you) *of the theological* "*uſe of natural philoſophy*, endeavouring to make the contemplation of the creatures contributory to the inſtruction of the prince, and to the glory of the author of them. But my "blood has ſo thickned my ink, that I cannot yet make it run; and my thoughts of improving the creatures have been very much diſplaced by thoſe of leaving them. Nor has my "diſeaſe been more guilty of my oblivion, than my employment, ſince it has begun to releaſe me; for *Vulcan* has ſo tranſported and bewitched me, that as the delights, I taſte in it, "make me fancy my laboratory a kind of Elyſium, ſo, as if the threſhold of it poſſeſſed the "quality the poets aſcribed to that *Lethe*, their fictions made men taſte of, before their "entrance into thoſe ſeats of bliſs, I there forget my ſtandiſh and my books, and almoſt "all things, but the unchangeable reſolution I have made, of continuing till death your &c"

HE was at *London* on the 15th of November, 1649; on the 20th of the ſame month at *Marſton*; on the 21ſt of December, and in the month of January following, again at *London*; and on the 1ſt of May, 1650, at *Stalbridge*, whence he wrote the following letter to Mr. *Hartlib*.

"SIR,

"I HAVE here ſo little time to diſpatch a great deal of indiſpenſable buſineſs in, that "my knowledge of your goodneſs, and yours of my hurry, promiſes me your pardon "for the neceſſitated fault of returning to ſo long and ſo excellent a letter ſo ſhort and ſo "haſty an anſwer, which ought to be wholly employed in acknowledgments and thanks for "the exact intelligence you are pleaſed to oblige me with from *Utopia* and *Breda*; my incli-"nation as much concerning me *in Republicâ Literariâ*, as my fortune can do *in Republicâ* "*Anglicanâ*. Nor am I here altogether idle, though my thoughts only are not at preſent uſe-"leſs to the advancement of learning; for I can ſometimes make a ſhift to ſnatch from the "importunity of my affairs leiſure to trace ſuch plans, and frame ſuch models, as, if my "Iriſh fortune will afford me quarries and woods to draw competent materials from, to con-"ſtruct after them, will fit me to build a pretty houſe in *Athens*, where I may live to philo-"ſophy, and Mr. *Hartlib*,

Stalbridge,
May-day, 1650.

"A cordial friend, and not wholly uſeleſs ſervant,

"R. B.

"IN great haſte, which I beſeech you pardon.

[a] Mr. *Boyle*'s letter to Mr. *Marcombes*, dated from *London*, Febr. 22, 1647-8, in which he mentions his intentions of ſetting out for *Holland* the next day. [b] See his Works, Vol. V. p. 235. [c] Ibid. p. 237.
[d] Ibid. p. 237, 238. [e] Ibid. p. 238.

To

To this I ſhall add here another letter to the ſame gentleman, the date of which is wanting.

" Dear Mr. *Hartlib*,

" I AM ſure, that you have too much charity to want juſtice; and therefore on the ſcore of " your ſerious promiſe I am bold, not only to deſire, but to expect at your hands a *Mercu-* " *rius Philoſophicus*, in an account of the projects and ſucceſſes of that *college*, whereof God " has made you hitherto the midwife and nurſe. I ſhall not beg any information from " you of that *diurnal* news, of which a whole ſheet may be had for a peny, and yet " be over-bought. No, I will ſtint my requeſts to your *Utopian* intelligence, as the " only way to keep me in charity with men, by letting me ſee, that the degenerate world " yet harbours ſome, that do not undeſerve the name. As for me, knowing, that my let- " ters will be guilty of faults enough in rhetoric, without loading themſelves with any need- " leſs crimes in morality, I here openly diſclaim all compliments, and ſolemnly engage my " ſelf (as to me) to give them a perfect baniſhment from our converſe, wherein I am confi- " dent I ſhall have but a very eaſy office to ſurmount; ſince for my part I ever eſteemed " them at beſt but the froth (not to ſay the ſcum) of civility; and for yours, I know the " gallantry of your principles leads you to the nobleſt way of putting them out " of countenance, by carrying you to doing men really more good than they dare promiſe. " And ſince you do not diſdain the meaneſt workman, that is but willing to lay ſome few " ſtones towards the building of your *college*, I ſhall in my following epiſtles (if this procure " them a paſs) take the liberty to acquaint you with what thoughts and obſervations of mine " I ſhall judge uſeful in reference to ſo glorious a deſign; to which I ſhall think it very much " my happineſs, if any endeavours of mine can have the honour in the leaſt meaſure to " contribute, not only as they owe a duty to the public (though, I muſt confeſs, that of " itſelf a very prevalent motive) but becauſe I know you ſo vaſtly affectionate to that public, " that my invention will furniſh me with no fitter way, than that of my ſervices to it, to " give you real and accepted teſtimonies of my being," &c."

HE had now gained ſo eminent diſtinction in the republic of learning, that in 1651 Dr. *Nathaniel Highmore*, a phyſician, who had been a member of *Trinity* college in *Oxford*, addreſſed to him his Treatiſe, printed at *London* that year, under the title of *The Hiſtory of Generation; examining the ſeveral opinions of divers authors, eſpecially that of Sir* Kenelm Digby *in his* Diſcourſe of Bodies. *With a general relation of the manner of Generation as well in plants as animals; with ſome figures delineating the firſt originals of ſome creatures, evidently demonſtrating the reſt. To which is joined a Diſcourſe of the Cure of Wounds by Sympathy, or without any real application of medicines to the part affected, but eſpecially by that power, known chiefly by the name of Sir* Gilbert Talbot's *powder*. The dedication is dated from *Sherborne* May 15, 1651, with this inſcription, *To the honourable Mr.* Robert Boyle, *ſon to the right honourable the earl of* Corke, *my much honoured friend*; and begins thus:

" Noble Sir,

" WHERE virtue ſhall be found in conjunction with nobility in ſuch black, the laſt " and worſt times, it no leſs invites and amazes the eyes and hearers of beholders, " than ſome new ſtar or blazing comet; but with this difference, the one is cauſe of their " fear, the other gives life to their hopes and joy. You have, Sir, ſo enriched your tender " years with ſuch choice principles of the beſt ſort, and even to admiration managed them " to the greateſt advantage, that you ſtand both a pattern and wonder to our nobility and " gentry, who in theſe paſt times, many of them, have ſo ſpent their precious minutes, that " they are ſcarce able to account for one, or ſpend an hour but in vice; that cannot brook " virtue, becauſe it it not born with them; that hate all things, that muſt be obtained by " induſtry; who moſt degenerately intruſting their wits as well as fortunes with their infe- " riors, have made them maſters of both; a ſad forerunner (I will not ſay author) of theſe " ſadder times. But you have made a better and far nobler choice; you have not thought " your blood and deſcent debaſed, becauſe married to the arts. You ſtick not to trace na- " ture in her moſt intricate paths; to torture her to a confeſſion, though with your own ſweat " and treaſure obtained."

IT was about the year 1652, that Mr. *Boyle* began an *Eſſay on the Scripture*, ſtill extant in manuſcript, from which his *Conſiderations on the Style of the Scriptures* were chiefly taken. This is evident from a letter of his, dated June 19, 1652, to his brother the lord *Broghill*, at whoſe requeſt he compoſed that *Eſſay*; which letter, with a few alterations, was afterwards made the Epiſtle Dedicatory to the *Conſiderations on the Style*, &c. Under what diſadvantages the *Eſſay* was written, the reader is informed in the preface to the *Conſiderations*: " The Eſſay, " *ſays he*, having not been all written in country, but partly in *England*, partly in another " kingdom, and partly too on ſhip-board, it were ſtrange, if in what I writ, there did not " appear much of unevenneſs, and if it did not betray the unleiſuredneſs, and reliſh of the " unſettledneſs of the wandering author, who by thus rambling was reduced, for want of a " library, to comply with the requeſt of his friend, who was more deſirous to receive from " the author apples and pears growing in his own orchard, than oranges and lemons fetched " from foreign parts." A diſcourſe written in this manner, without any foreign aſſiſtance,

and under ſo many diſadvantages in the exerciſe of his own talents, ſhews his abilities in a much more conſpicuous light, than if he had compiled ſome finiſhed piece with the uſual helps, and at a time of leiſure and freedom from diſtractions. The publick will undoubtedly be glad to ſee his thoughts concerning the laſt Engliſh tranſlation of the Bible, and of the advantage of underſtanding the original languages of the ſcriptures, with ſome account of his own application to the ſtudy of them, extracted from ſome looſe ſheets, intended as a part of his *Eſſay on the Scripture*.

" THOUGH I think, ſays he, the authors of our laſt tranſlation have made it much more " correct than our former was, and preferable to moſt I have met with in other languages; " and have therefore been ſincerely and induſtriouſly inſtrumental to the Britiſh churches edi- " fication, according to their light; yet that it were very poſſible, as well as to be wiſhed, " that an Engliſh tranſlation, yet in many places more correct, might be framed, will ſcarce " ſeem improbable to an intelligent perſon, that duly conſiders, how much the knowledge of " tongues, and (what would be highly uſeful, not to ſay neceſſary, in ſuch a work) of Jewiſh " and other Eaſtern learning, is, ſince our laſt verſion was made, encreaſed and refined, and " conſequently, how many texts by that greater light, that now ſhines among critics and an- " tiquaries, may be rendered more fully, or more warily, or more clearly, or more cohe- " rently to the context, or more congruouſly to the analogy of faith, or that of reaſon.

" I CANNOT but reckon the want of (not ſuperficial rudiments, but) ſolid knowledge and " practical readineſs in the originals of the Bible amongſt the chief impediments of our diſ- " covery of the נפלאות *niphlaſt*, or unobvious rarities of that divine book, from which he " much derogates, that ſtints them to thoſe diſcernible in a tranſlation. But I pretend not, " by what I have now ſaid, or reſerve to ſay elſewhere, either to impoſe a neceſſity of learn- " ing Greek and Hebrew on thoſe, whoſe incapacities or employments deny them the requi- " ſites or conveniences of ſuch a ſtudy; or to diſcourage thoſe, that cannot underſtand the " Scriptures in its originals, for reading it in tranſlations; for (at leaſt among his own chil- " dren) he, that requires leſs, where leſs hath been intruſted, will not exact a meaſure of " knowledge diſproportionate to the means he hath vouchſafed of it; and tranſlations of the " Bible may be very effectual to God's purpoſes in it, though not ſo much ſo as their ori- " ginals to all, eſpecially as to the practical maxims of religion. Experience makes it pro- " bable, that tranſlations hold them forth clearly and unanimouſly enough to make their " faithful practicers acceptable unto God through Jeſus Chriſt, as the Egyptians were won- " drouſly enriched by the river *Nilus*'s ſtreams flowing from an unknown fountain. To " which purpoſe I remember, that that excellent Chriſtian ſcholar and divine Dr. *Uſher*, " archbiſhop and primate of *Armagh*, (whoſe encouragements I gratefully acknowledge to " have much engaged me to the ſtudy of the holy tongues) talking to me one day in his " ſtudy of his intended edition of the Septuagint, earneſtly implored of him by the tranſ- " marine critics, obſerved to me, not without ſome juſt wonder, that for divers ages the " church (as to the greater part of it,) and even the apoſtles, and even thoſe, that moſt " flouriſhed in piety, ſcarce uſed any other ſcripture than the Septuagint's tranſlation, which " is one of the faultieſt verſions of the Bible, and wants not groſs miſtakes. And indeed, " ſo there be a devout, induſtrious, and modeſt ſearch after the truths of ſcripture propor- " tionable to the abilities and opportunities, that God vouchſafes, and a conſcionable conform- " ing of our lives to our diſcoveries, it is much to be hoped, that we may miſs a great many " theological truths without miſſing ſalvation. But as I ſhall not exact the ſtudy of the ori- " ginal from thoſe, whoſe want of parts or leiſure diſpenſeth them from it; ſo cannot I but " diſcommend thoſe, who wanting neither abilities, time, nor conveniences to range tho- " rough I know not how many other ſtudies, can yet decline this; and who ſparing no toil " nor watches to put it out of the power of the moſt celebrated philoſophers to deceive them " in another doctrine, leave themſelves obnoxious to the ignorance, fraud, or partiality of " an interpreter in that of ſalvation; and thereby ſeem more ſhy of taking any opinions " upon truſt, than thoſe, in whoſe truth or falſeneſs no leſs than God's glory, and peradven- " ture their own eternal condition, is concerned. Methinks thoſe, that learn other languages, " ſhould not grudge thoſe, that God hath honoured with ſpeaking to us, and employed to " bleſs us with that heavenly doctrine, that comes from him, and leads to him. When I " have come into the Jewiſh ſchools, and ſeen thoſe children, that were never bred up for " more than tradeſmen, bred up to ſpeak (what hath been peculiarly called) God's tongue, " as ſoon as their mother's, I have bluſhed to think, how many gown-men, that boaſt them- " ſelves to be the true *Iſraelites*, are perfect ſtrangers to the language of *Canaan*; which I " would learn, were it but to be able to pay God the reſpect uſual from civil inferiors to " princes, with whom they are wont to converſe in their own languages. For my part, " I * * * that have a memory ſo unhappy and ſo unfit to [ſupply] my intellectual deficiencies, " and the reſt of my diſabilities, that it often ſtrongly tempts me to give over my ſtudies, and " abandon an employment, wherein my ſlow acquiſts are (by the treacherouſneſs of my me- " mory) ſo eaſily loſt; beſides this diſadvantage, I ſay, thoſe excellent ſciences, the mathe- " matics, having been the firſt I addicted myſelf to, and was fond of, and experimental " philoſophy with its key, chemiſtry, ſucceeding them in my eſteem and applications; my " propenſity and value for real learning gave me ſo much averſion and contempt for the " empty ſtudy of words, that not only I have viſited divers countries, whoſe languages I

" could never vouchſafe to ſtudy, but I could never yet be induced to learn the native " tongue of the kingdom I was born and for ſome years bred in. But in ſpite of the " greatneſs of theſe indiſpoſitions to the ſtudy of tongues, my veneration for the ſcripture " made one of the greateſt deſpiſers of verbal learning leave *Ariſtotle* and *Paracelſus* to turn " grammarian, and where he could not have the help of any living teacher, engaged him " to learn as much Greek and Hebrew, as ſufficed to read the old and new teſtament, " merely that he may do ſo in the Hebrew and Greek, and thereby free himſelf from the " neceſſity of relying on a tranſlation. And after I had almoſt learned by rote an Hebrew " grammar, to improve myſelf in ſcripture-criticiſms, in the Jewiſh way of reading the " oracles committed to them, I, not over-cheaply, purchaſed divers private conferences with " one of their ſkilfulleſt doctors (as St. *Hierom* had thoſe nocturnal meetings, which ſo much " helped to make him the ſolideſt expoſitor of all the fathers, with *Barraban* or * * * the " Jew) I received of him few leſſons, that coſt me not twenty miles riding, at a time, when " I was in phyſic, and my health very unſettled. A Chaldee grammar I likewiſe took the " pains of learning, to be able to underſtand that part of *Daniel*, and thoſe few other porti- " ons of ſcripture, that were written in that tongue; and I have added a Syriac grammar " purely to be able one day to read the divine diſcourſes of our Saviour in his own language; " in which I can truly profeſs, with the famous publiſher of the Syriac teſtament, *Guido Fabricius*, " (in his dedication of that book, and his verſion of it, to the then *French* King) that I had " no inſtructor to teach me ſo much as to know the letters, but have been, to uſe the words " he borrows of the learned *Budæus*, αὐτοδίδακτος καὶ θεοδίδακτος, have had no other living " teacher but God and myſelf in the little grammatical learning I have acquired in thoſe " four tongues, in which the better underſtanding and reliſhing of the ſcripture limit my " pretenſions. Nor do I at all repent my labour, though, to ſecure my progreſs and acquiſts " in theſe languages, my bad memory ſtill reduces me to a conſtant and frequent recollection " of ſome choice inſtitutions of them all. For certainly the ſatisfaction of underſtanding " God, and thoſe excellent perſons celebrated even in his book, expreſs themſelves in their " own very terms and proper languages, doth richly recompence the pains of learning them; " for, according to the known ſaying,

" *Quamvis allatâ gratus ſit ſæpe in undâ,*
" *Dulcius ex ipſo fonte bibuntur aquæ.*

" Though we ſtream-waters not unpleaſant think,
" Yet with more guſto of the ſpring we drink.

" IT is true, that a ſolid knowledge of that myſterious language, God and his prophets " ſpake (whatever is given out to the contrary by ſuperficialiſts, amongſt whom I remem- " ber a Jewiſh profeſſor of my acquaintance uſed to reckon many, that are thought and " think themſelves Hebricians, becauſe they could without heſitation and the help of a " tranſlation or a dictionary read and render in their own tongue an Hebrew chapter) is, " I ſay, ſomewhat difficult, but not ſo difficult, but that ſo ſlow a proficient as I could in leſs " than a year, of which not the leaſt part was uſurped by frequent ſickneſſes and journies, by " furnaces, and by (which is none of the modeſteſt thieves of time) the converſation of " young ladies, make a not inconſiderable progreſs towards the underſtanding of both teſta- " ments in both their originals. * * *

" FOR my part, that reflect often on *David*'s generoſity, who would not offer as a ſacrifice " to the Lord his God that which coſt him nothing, I eſteem no labour laviſhed, that il- " luſtrates or endears to me that divine book; my addictedneſs to which I gratulate to myſelf, " as thinking it no treacherous ſign, that God loves a man, that he inclines his heart to " love the ſcriptures, where the truths are ſo precious and important, that the purchaſe " muſt at leaſt deſerve the price. And I confeſs myſelf to be none of thoſe lazy perſons, that " ſeem to expect to obtain from God the knowledge of the wonders of his book upon as " eaſy terms, as *Adam* did a wife, by ſleeping profoundly, and having her preſented to him " at his awaking."

IN the ſame year 1652 he went to *Ireland*, whence he wrote the following letter in January 1652-3 to *his highly honoured friend John Mallet, Eſq; at Poyington, near Sherburne in Dorſetſhire.*

" SIR,

" IT is ſo long ſince, that I have been made happy in an unanſwered letter of yours, that " it would now almoſt as juſtly produce my bluſhes, that it hath lain ſo long unacknow- " ledged, as it did then my ſatisfaction to find it ſo obliging; if it had not ſo abruptly come " to my hands, and with ſo many other papers, that till I was this afternoon informed by " Mr. *Lillyes*, that he ſent it me, I neither knew by whom you had written it me, nor by " whom I might ſecurely return you for it my highly merited thanks. But though this ig- " norance leſſened, it deſtroyed not the happineſs I received in a paper, whoſe writer kept " it from needing endearing circumſtances. And certainly without a huge deal of inſenſibility, " I could not but be highly ſenſible of a civility, that came to ſeek me out in a country,

" which thoſe, that have the moſt relation to it, ſeldom think on any longer than they are " in it. Nor was I only mightily affected to find the welcome continuation of your friend- " ſhip for me, but very much delighted to find too, that you began to have a friendſhip for " the Eaſtern tongues. For though to a perſon ſo uſed to the ſtudy, and repleniſhed " with the knowledge of things, as Mr. *Mallet*, the learning of words cannot but at firſt be " very tedious; yet ſince to be a good grammarian is neceſſary to be a good divine; and he, " that hath no ſkill in the original ſcripture himſelf, may be deluded by thoſe, that tranſlate " it for him; you will find a rich compenſation for the trouble of learning the holy tongue " in the advantages of having learned it; and by the help of that primitive language, " wherein they were written, you may gain a free and ſafe acceſs to thoſe theological myſte- " ries, which he, that is no linguiſt, muſt either totally ignore, or take upon truſt. And " certainly a knowledge ſo directly conducive to that knowledge, that is called *life eternal*, " cannot but deſerve the being laboured for. And to ſatisfy you, that the difficulties of at- " taining ſo precious a knowledge are not inſuperable, I ſhall tell you, that I have a young " kinſwoman newly marriageable, who to the French and Latin hath added ſkill enough in " the Greek and Hebrew tongues to read the two teſtaments in them. I am glad to hear " by Mr. *Lillyes*, that you have got ſo good an inſtructor as Mr. *Bythner*, whoſe ſhort " grammar of the laſt edition is that, for which I left off many others of the moſt approved, " after having ſurveyed them all. But his inſtitutions being almoſt confined to the etymolo- " gical part of grammar, are chiefly proper for a beginner; and therefore, when you are " proficient enough to decline moſt nouns, and conjugate (though not all verbs) all ſorts of " verbs; it would be requiſite for the ſyntactical part of grammar to have recourſe to ſome, " that have handled it expreſly; wherein next *Glaſſius* (whoſe works are voluminous enough, " and of various ſubjects, but, in my green judgment, theological and excellent) the elder " *Buxtorfius* hath been the moſt full and accurate of thoſe I have yet met with. There is " likewiſe an old book of *Flacius Illyricus*, which he calls *Clavis Scripturæ*, which, though " little taken notice of, is more than a little uſeful, and very well worth peruſing; ſince " giving the reader a particular account of the Hebraiſms, as they lie in ſcripture, he often- " times teaches him at once both grammar and divinity. But I muſt beg your pardon for " troubling you with theſe perhaps needleſs advertiſements: I have cauſe to believe " Mr. *Bythner*'s will be much riper; only the prejudice I ſuſtained, by not having ſeaſonably " an addreſs to the authors I have named, makes me willing, rather to hazard the exerciſe " of your patience by ſuperfluous directions, than venture to let you miſpend any of your " ſtudious hours, for want of ſuch addreſſes, as are not bad, though they prove not the very " beſt. I forget to tell you, that there is one *Gerhard* (ſon of the famous Lutheran divine) " who hath publiſhed an Harmonical Synopſis of the Hebrew, Chaldee, Syriac, Arabic, and " Ethiopic tongues; which would be no bad iſagoge to the Eaſtern languages, if it were not " ſo wretchedly falſe printed, that it expoſes the learned in almoſt every page to perplexities " or miſtakes. I wiſh I could give you ſome account of my ſtudies here; but I muſt ſadly " confeſs, that the perpetual hurry I live in, my frequent journeys, and the neceſſary trouble " of endeavouring to ſettle a very long neglected and disjointed fortune, have left me very " little time to converſe with any book, ſave the Bible, and ſcarce allowed me leiſure to ſew " together ſome looſe ſheets, that contained my thoughts about the ſcripture, of which I wiſh " I had a copy to ſubmit to your cenſure. But I hope by God's bleſſing to be able to bring " over one myſelf this ſpring into your parts; to which it is not my leaſt of invitations, that " I ſhall there enjoy the happineſs of a converſation, that hath made me upon ſo many ſcores,

" SIR,

" your moſt affectionate friend

" and obliged humble ſervant,

" ROBERT BOYLE.

" MY moſt humble ſervice, Sir, I beſeech you, to Sir *Thomas Mallet* and my lady, and the " fair young lady you are happy in. And I ſhall beg you to do me the favour to convey " my high reſpects to the *Sherborne* family, when you go thither. The news here is not con- " ſiderable enough to deſerve your notice. My friends here are, God be praiſed, well, and " thoſe that have the happineſs to know you, much your ſervants."

HE came back from *Ireland* to *England*, probably about Auguſt 1653, and was at *London*, where he met with Dr. *John Wilkins*, then warden of *Wadham* college in *Oxford*, and afterwards biſhop of *Cheſter*, to whom he intimated his reſolutions of ſettling at *Oxford* [a]. In September he was a few days at *Stalbridge*; but being obliged by his affairs to return to *Ireland*, in his way thither he wrote the following letter to his friend Mr. *Mallet*.

[a] See Dr. *Wilkins*'s letter of Sept. 3, 1653, Vol. V. p. 629, 630.

" SIR,

" SIR,

" IF the ſuddenneſs of that unwelcome neceſſity, which hurried me from *Stalbridge*, would " have allowed me ſo much as two days ſtay in thoſe parts, I ſhould not be now reduced " to make you an apology for my leaving *Stalbridge*, before I kiſſed your hands at *Poynington*. " And though the urgency of my occaſions allowed me but one day to pack up bag and " baggage, and ſettle my affairs there, I ſhould have ſpent part of that day in paying you " the duty, and giving myſelf the ſatisfaction of a viſit, if the greateſt obſtacle, my haſte " put to my deſires, had not been the tiredneſs of my horſes by my preceding journies. " The apprehenſion of loſing my paſſage, unleſs my arrival here prevented the feared change " of the wind, poſted me ſo abruptly hither, that it allowed me to comply, neither with " my civility, nor with my inclinations, the latter of which are never more gratified than in your " charming converſation, which the wind's croſſneſs ſince my arrival here makes me very much " regret I did not venture to give myſelf the happineſs of. The ſad condition of *Ireland* mak- " ing me ſomewhat irreſolute of my going thither this winter, I do not wholly deny myſelf " the pleaſing thoughts of being happy in your company at *Poynington*. But in caſe a fair wind " blow away thoſe thoughts, I muſt implore, in the want of your immediate converſation, " that which is practiſed by letters, as the next contentment to the former by nearlieſt ap- " proaching it. In the neceſſity of repairing into *Ireland* to ſettle my affairs there, now " things ſeem tending to a ſettlement in that unhappy country, I ſhall leave behind me at " *Stalbridge* the bearer, *Roger Ball*, and with him a leaſe of that manor for ſome yet unexpired " years; in which leaſe you were pleaſed to allow me to have your name put in as a truſtee " for me. The reaſon of my mentioning this to you is, that by the miſtaking confidence " of honeſt old Mr. *Mawdeſley*, then ſteward of my courts at *Stalbridge*, I made ſeveral " grants there, as preſuming I had power to do ſo; which, upon more knowledge of the law, " and a more heedful peruſal of my own more than ordinarily ſtrict entail, I found, though " hardly overthrowable in equity, yet to be queſtionable in ſtrictneſs of law. My juſt ten- " derneſs in caſes of this nature made me extremely troubled, that my ignorance had made " me do what knowingly nothing ſhould; and therefore by Sir *Thomas Mallet*'s excellent " advice, finding a leaſe of *Stalbridge* for about thirty years unexpired to remain in the hands " of an old ſervant of my father's, I made it one of my motives to go into *Ireland*, and one " of my concerningeſt buſineſſes there, to get this leaſe aſſigned over in truſt to your ſelf and " *Roger Ball*, with whom I have left order, that in caſe God ſhould call me to himſelf before " my return to *Stalbridge*, he ſhall beg you to join with him in making every tenant, " whoſe grant is queſtionable, a leaſe of as many years, as your authority extends to grant, " that ſo theſe poor men, in caſe their titles (contrary to my expectation and to probability) " ſhould be overthrown as to their firſt grants, may have a good title to all the unexpired " years of your leaſe; and that number, according to common eſtimation, will be as ad- " vantageous, if not better, than their firſt grants. I find, Sir, no ſmall trouble in the ne- " ceſſity of giving you this great one; but I am confident you are ſuch a friend to juſtice, " that you will pardon a fault, that proceeds only from ſome tenderneſs of that virtue in a " ſervant of yours, who very well knowing gratitude to be a virtue, as well as juſtice, if not " part of it, is not made more deſirous by the laws of the former virtue to ſecure his tenants, " than the duties of the latter will make him of the opportunity of expreſſing and evincing, " how highly he is Mr. *Mallet*'s

" affectionate, faithful, and obliged

Briſtol, Sept. 23, 1653.

" humble ſervant,

" ROBERT BOYLE.

" I SHALL beg the favour of having my moſt humble ſervice preſented to Sir *Thomas* " *Mallet* and my lady, and to your own fair lady, with the reſt of your family; to all " which you have engaged me to be a ſervant. If the bearer ſhall, in my abſence, ap- " ply himſelf to you for directions, your vouchſafing them to him will very much oblige " me. If you pleaſe to make me at any time happy in your letters, it will as well inſtruct " as ſatisfy me, to be informed, how you proceed in relation to your Eaſtern ſtudies."

HE purſued his intended journey to *Ireland*; for we find him there in January 1653-4 [a], where he propoſed to continue till Midſummer 1654 [b], though his reſidence in that kingdom was by no means agreeable to him, ſince in a letter [c], which he wrote in the beginning of that year to Mr. *Clodius*, an eminent chemiſt, who married the daughter of Mr. *Hartlib*, he ſtiles it " a barbarous country, where chemical ſpirits were ſo miſunderſtood, and chemical in- " ſtruments ſo unprocurable, that it was hard to have any Hermetic thoughts in it." For this reaſon he exerciſed himſelf in making anatomical diſſections, being aſſiſted therein by his friend, Dr. (afterwards Sir) *William Petty*, then phyſician to the army and to the deputy of

[a] See Mr. *Hartlib*'s letter to him of Feb. 28, 1653-4, Vol. V. p. 257.
[b] Ibid. p. 242, and 261.
[c] Ibid. p. 241, 242.

Ireland, and one of the moſt extraordinary men of his time, who in 1648, at the age of twenty five, inſcribed to Mr. *Hartlib*, *Advice for the Advancement of ſome particular parts of Learning*, printed at *London* in 4to; in which he gives plans of a mechanical and medical college, wherein youths might be educated, and the hiſtory of all mechanical arts and trades tranſmitted to poſterity; and this piece ſeems to have been one of the firſt draughts of a philoſophical college, that was ever made in *England*. Mr. *Boyle* was brought acquainted with this gentleman by means of Mr. *Hartlib*, as early as the year 1647 [a]; and received great advantage, while he continued in *Ireland*, from his converſation and their joint ſtudies in anatomy; in the courſe of which "I ſatisfied myſelf (ſays he [b]) of the circulation of the "blood, and the freſhly diſcovered and hardly diſcoverable *receptaculum chyli* made by the "confluence of the *venæ lacteæ*, and have ſeen (eſpecially in the diſſections of fiſhes) more "of the variety and contrivances of nature, and the majeſty and wiſdom of her author, "than all the books I ever read in my life could give me convincing notions of."

HE made alſo ſtrict enquiries after the minerals, which *Ireland* afforded; and though he could meet with few, who had either ſkill or curioſity in that way, yet ſilver ore was brought to him, which was found upon one of his brother's eſtates, that upon trial was eſtimated to be worth between thirty and forty pounds a tun. A ſilver mine was then farmed of the ſtate; and he was aſſured by experienced men, that *no country in Europe was ſo rich in mines as Ireland, had but the inhabitants the induſtry to ſeek them, and the ſkill to know them* [c].

AFTER his return to *England*, which was probably, according to his intentions, in the latter end of June, 1654, he went to reſide at *Oxford*, in order to proſecute his ſtudies with the greater advantage, and continued there for the moſt part till April, 1668, when he ſettled at *London* in the houſe of his ſiſter *Ranelagh* in *Pall-Mall*. At *Oxford* he choſe to live in a private houſe, rather than in a college, both for his health, and becauſe he had more room and conveniency to make experiments, than he could have had in a ſociety. The perſon, with whom he lodged was Mr. *Croſſe*, an apothecary, whoſe great acquaintance with Dr. *John Fell*, afterwards biſhop of *Oxford*, (who made him one of the executors of his pious and charitable will,) and his own noble foundation of an hoſpital near *Ampthill* in *Bedfordſhire*, for the maintenance of thirteen decayed citizens of *Oxford*, give him a right to be mentioned with honour in this hiſtory [d]. *Oxford* indeed was the only place in *England*, where at that time Mr. *Boyle* could have lived with much ſatisfaction to himſelf. Dr. *Wilkins*, who had married a ſiſter of *Oliver Cromwell* the Protector, was a man of excellent temper, and admirable abilities, and by the influence of his example and authority, ſupported a ſpirit of rational piety, and a right taſte of learning in that univerſity. Dr. *John Wallis* and Dr. *Seth Ward*, the two Savilian profeſſors of geometry and aſtronomy, Dr. *Thomas Willis*, the phyſician, then ſtudent of *Chriſt-Church*, Mr. *Chriſtopher Wren*, then fellow of *All-Souls* college, Dr. *Goddard*, warden of *Merton* college, Dr. *Ralph Bathurſt*, fellow of *Trinity*, and afterwards preſident of the ſame, and dean of *Wells*, were eminent likewiſe for their genius and application to the moſt uſeful parts of literature, which theſe great men united their endeavours to cultivate and promote. For this purpoſe they held frequent meetings, in which they conferred chiefly on philoſophical ſubjects; and being ſatisfied, that there was no certain way of arriving at any competent knowledge, unleſs they made a variety of experiments upon natural bodies, in order to diſcover what phænomena they would produce, they purſued that method by themſelves with great induſtry, and then communicated their diſcoveries to each other.

THIS was an employment, and this a ſociety, which exactly ſuited Mr. *Boyle*'s inclinations. He had before laid in a great ſtock of mathematical and chemical knowledge: and as for the *Ariſtotelian* way of explaining the phænomena of nature, he rejected it, as a mere ſyſtem of words, that would never make any man more intelligent than he was before. The *Carteſian* philoſophy began to make a noiſe in the world; but he reſolved to acquieſce in no ſingle man's hypotheſis, and to draw no concluſions from premiſes in natural things, which he could not actually verify himſelf; and ſo for many years he would not read over *Des Cartes*'s *Principles*, leſt he might be biaſſed by the ingenuity or authority of that philoſopher. With theſe diſpoſitions he ſet himſelf to phyloſophiſe, and to perſuade the nobility and gentry of the nation, who had the means and leiſure to purſue ſuch ſorts of ſtudies, to follow his example. He was convinced, that it would be of ineſtimable uſe to mankind to engage them in theſe enquiries; it would divert them from thoſe impertinent and criminal amuſements, with which moſt of them buſied themſelves, and would make them not only better Chriſtians, but likewiſe more uſeful members of ſociety.

IT was during Mr. *Boyle*'s reſidence at *Oxford*, that he invented that admirable engine, the *Air-Pump*, which was perfected for him, in 1658 or 1659, by the very ingenious Mr. *Robert Hooke*, after he had ſeen a contrivance for that purpoſe by Mr. *Graterix*, which was too groſs to perform any great matters [e]. Mr. *Hooke*, who was afterwards profeſſor of geometry in *Greſham* college, and doctor of phyſic, then lived with Mr. *Boyle*, whom he aſſiſted in chemiſtry, having been recommended to him by Dr. *Willis* the phyſician, whom he had before ſerved in the ſame capacity [f]. By this engine Mr. *Boyle* made ſuch experiments, as have gone very

[a] Vol. V. p. 256. [b] Ibid. p. 242. [c] Ibid. [d] Dr. *Wotton*'s papers, c. iii. §. 1. [e] Life of Dr. *R. Hooke*, by *R. Waller*, Eſq; p. 3. [f] Mr. *Ward*'s lives of the profeſſors of *Greſham* college, p. 170.

far to enable him, and thoſe who have ſucceeded him, to form a juſt theory of the air. By this he demonſtrated its elaſticity; and that property alone was a means to find out abundance more. He begun alſo to compoſe hiſtories of its particular qualities, all founded upon experiments or obſervations, of which he kept very exact regiſters, hoping by this means to leave ſuch materials, as future ages might build complete theories upon. There were at that time no philoſophical ſocieties erected in other parts of *Europe*: what men had hitherto performed, they had moſtly done upon their ſingle ſtock, and that rather by the way of abſtracted reaſonings, than by making experiments. In *Italy* indeed the great *Galileo*, and his ſcholar *Evangeliſta Torricelli*, had made ſome experiments, which had excited the curioſity of mankind; as did eſpecially that famous one of the former, in which by a tube filled with water, inverted and plunged into a veſſel of the ſame, he kept a cylinder of it ſuſpended at the height of thirty four feet; by which the weight of the air was firſt demonſtrated. The philoſophy of *Des Cartes* had for ſome years been publickly taught in *Holland*; and though built upon principles very oppoſite to thoſe either of *Ariſtotle*, or the chemiſts, yet had not the neceſſary vouchers of repeated experiments, purpoſely tried, to make it good. However that philoſopher had done eminent ſervice, in leſſening the devotion, which had been implicitly paid to *Ariſtotle*'s philoſophy, and infuſing an inquiſitive ſpirit into mankind. A diſpoſition to think freely concerning the cauſes of natural things had now ſpread itſelf in *England*, *France*, and *Italy*; and that diſpoſition occaſioned all thoſe alterations in men's way of ſtudy, and produced all thoſe extraordinary diſcoveries of nature, which diſtinguiſhed the laſt age.

BUT philoſophy and enquiries into nature were not the only things, which engaged Mr. *Boyle*'s attention. His eyes were then ſtrong enough to follow thoſe critical ſtudies, which he had begun before, and which he thought neceſſary to underſtand the ſcriptures thoroughly: and for this he had peculiar advantages at *Oxford*. Dr. *Edward Pococke*, Mr. *Thomas Hyde* of *Queen*'s college, and Mr. *Samuel Clarke*, who were men of great eminence for their ſkill in the Eaſtern languages, reſided there; and Mr. *Hyde* particularly was frequently conſulted by him during the reſt of his life upon any difficulties, which he met with in the courſe of his reading upon thoſe ſubjects. But one of his moſt intimate friends, with whom he converſed upon theological points, was Dr. *Thomas Barlow*, then chief library-keeper of the *Bodleian* library, and afterwards biſhop of *Lincoln*. The doctor was a man of prodigious reading, and a proportionable memory; he knew what the fathers, ſchoolmen, or canoniſts had ſaid upon any queſtion in divinity, or caſe of conſcience; and being with all theſe accompliſhments very communicative of his knowledge, he gained the higheſt degree of Mr. *Boyle*'s eſteem and friendſhip, who uſed, as long as he lived, to conſult him upon caſes of conſcience, wherein he was ſure at the ſame time of learning all that had been hitherto urged upon the queſtion propoſed to Dr. *Barlow* [a], many of whoſe anſwers are ſtill extant. But however important theſe advantages were, which he enjoyed at *Oxford*, for the proſecution of his ſtudies, he extended them by a correſpondence with perſons eminent for their knowledge in other parts of *England*, and in foreign countries. Among theſe correſpondents, one of the principal was, *Henry Oldenburg*, Eſq; a native of *Bremen* in *Lower Saxony*, who was for ſevera ylears agent for that city in *England*, and afterwards tutor to the lord *Dungarvan*, nephew to Mr. *Boyle*, with whom he travelled abroad in the year 1657. He was at laſt ſecretary to the Royal Society, and died ſuddenly in September 1677, and his wife, the daughter of Mr. *John Dury*, dying about the ſame time, left two orphans, whom Mr. *Boyle* took care of for the preſent, no will of Mr. *Oldenburg* being found, nor had he or his wife any relation in *England*. The firſt letter extant of this gentleman to Mr. *Boyle* is dated April 15, 1657; and in another written from *Saumur* in *France* in the latter end of that year, he mentions his [b] ſatisfaction, that the council had granted Mr. *Boyle*'s deſires for the promotion of knowledge; "which (ſays he) I ſuppoſe to be thoſe, that were couched in a certain petition you "were pleaſed to impart unto me at *Oxford*; wherein, if I remember well, a matter of "twelve thouſand pounds ſterling was offered to purchaſe confiſcated lands and houſes with in "*Ireland*, and to commit the profit thereof into the hands of certain truſtees, for to em- "ploy it in the entertainment of an agent, ſecretary, tranſlators, for keeping intelligence, "diſtributing rewards, *&c.* in order to the end aforeſaid."

DR. *John Beale*'s letters to him are very numerous, and upon ſubjects of great importance. This divine was born of a good family in *Herefordſhire*, and educated in *Eton* ſchool, whence he was tranſplanted to *King*'s college in the univerſity in *Cambridge*, where he ſoon diſtinguiſhed himſelf by his uncommon genius and learning. He was one of the firſt members of the Royal Society, and in 1665 was promoted to be chaplain to king *Charles* II. He was likewiſe doctor of divinity, and reſided chiefly at his living of *Yeovil* in *Somerſetſhire*, where he died about the year 1683. There are ſeveral of his papers in the *Philoſophical Tranſactions*.

ANOTHER of Mr. *Boyle*'s correſpondents, and moſt intimate friends, was *John Evelyn*, Eſq; of *Wotton* in *Surrey*, born there on the 31ſt of October, 1620, and educated at *Baliol* college in *Oxford*; who having travelled for ſeven years into the politer countries of *Europe*, upon his return to *England*, was one of the firſt of thoſe gentlemen, who met for the eſtabliſhment of the Royal Society. He paſſed through ſeveral conſiderable poſts in the reigns of king

[a] Dr. *Wotton*'s papers.

[b] Vol. V. p. 300.

Charles II.

Charles II. *James* II. and *William* III. and died at *London*, February the 27th, 1705-6, in the 86th year of his age [a]. His works are of various kinds and very valuable; and Dr. *Burnet* [b] ſtiles him *a moſt ingenious and virtuous gentleman*; and informs us, that he was *not ſatisfied to have advanced the knowledge of this age by his moſt uſeful and ſucceſsful labours about planting and divers other ways, but was ready to contribute every thing in his power to perfect other mens endeavours*. His acquaintance with Mr. *Boyle* began, as he obſerves himſelf, in his letter to Dr. *Wotton* [c], "from courteous viſits he made me at my houſe at *Say's-Court* [d], which I as "conſtantly repayed; ſo it grew reciprocal and familiar, divers letters paſſing between us at "firſt in civility, and the ſtile peculiar to him upon the leaſt ſenſe of obligation. But thoſe "compliments laſted no longer than till we became perfectly intimate, and had diſcovered "our inclinations of cultivating the ſame ſtudies and deſigns, eſpecially in ſearch of natural "and uſeful things, myſelf then intent on collections of notes in order to an *Hiſtory of Trade*, "and other mechanical furniture, which he earneſtly incited me to proceed in. So that our inter-"courſes of letters were now moſtly upon that ſubject, and were rather ſo many receipts and pro-"ceſſes, than matter of letters; what I gathered of this nature, (eſpecially for the improvement "of *Gardening* and *Sylva*, *Kalendarium*, *Acetaria*, &c. being but part of that work, a plan whereof "is publiſhed) would aſtoniſh you to ſee . . . Theſe deſigns and apparatus's growing beyond "my forces, were left imperfect, upon the reſtoration of the baniſhed King, when every "body expected a new world, and had other proſpects than what the melancholy and almoſt "deſpair ſuggeſted to paſs away anxious thoughts by thoſe innocent employments I have "mentioned; the eſtabliſhment of the Royal Society taking in all theſe ſubjects; which "made our perſonal meeting (unleſs at *Greſham* college, where we aſſiduouſly met and con-"verſed) leſs neceſſary." Among Mr. *Evelyn*'s letters is a very long and curious one [e], dated at *Say's-Court*, Sept. 3, 1659, and containing a ſcheme of a *Philoſophical College*, in which he wiſhed to have Mr. *Boyle* for a fellow-member, *who is alone*, ſays he, *a ſociety of all, that were deſirable to a conſummate felicity*. And on the 29th of the ſame month he wrote to him another letter [f], upon reading the manuſcript of Mr. *Boyle*'s *Seraphic Love*, which he had done with ſo high a ſatisfaction, that he obſerves at the concluſion of his letter, that "he extreme-"ly loved Mr. *Boyle* before, but that his heart was infinitely knit to him now. For what "(ſays he) are we now to expect from ſo timely a conſecration of your excellent abilities? "The *primitiæ* ſanctified the whole harveſt; and you have at once by this incomparable "piece taken off the reproach, which lay upon piety, and the enquiries into nature, that "the one was too early for young perſons, and the other the ready way to atheiſm; than "which, as nothing has been more impiouſly ſpoken, ſo nor has any thing been more con-"futed."

Dr. *John Pell* was another of Mr. *Boyle*'s friends. He was deſcended of an ancient family in *Lincolnſhire*, and born at *Southwyke* in *Suſſex*, of which his father was miniſter, on the 1ſt of March, $16\frac{10}{11}$. At thirteen years of age he was ſent to *Trinity* college in *Cambridge*, being at that time as good a ſcholar as moſt maſters of art in the univerſity, which degree he took in 1630, and ſoon became eminent for his ſkill in the mathematics, and in the Latin, Greek, Hebrew, Arabic, Italian, French, Spaniſh, and High and Low Dutch languages. He was ſeveral years profeſſor of mathematics at *Amſterdam*, and afterwards at *Breda*, and in 1654 was appointed envoy from the protector *Oliver* to the proteſtant cantons in *Swiſſerland*, where he continued till 1658. After the reſtoration he entered into holy orders, and became doctor of divinity, and chaplain to Dr. *Gilbert Sheldon*, archbiſhop of *Canterbury*, though he never enjoyed preferment equal to his merit, and died in mean circumſtances in the pariſh of St. *Giles's in the Fields*, on the 12th of December, 1685, and was interred in that church [g]. Among other pieces publiſhed by him, he tranſlated from the Low Dutch *A Tract touching the ſkill of a better Way of Anatomy of Man's Body*, *by* Yonker de Bills, *Lord of Koppenſdam*, printed at *London*, in 1659, in 12mo; to which Mr. *Boyle* wrote a preface, prefixed to that edition, which was procured by himſelf. Mr. *Hartlib*, in a letter to Mr. *Boyle* from *London*, dated November the 1ſt that year [h], mentions his intention to ſend a copy of this tranſlation and preface to monſieur *Bills* himſelf, *to let him know, what honour hath been done unto him by a young nobleman in theſe parts, and many more to friends in the Low Countries. Really*, continues he, *you have done an excellent work for ſpreading this anatomical magnale upon the honeſt learned world.* He ſent likewiſe the following extract of a letter, which he had juſt received from abroad, with relation to the author himſelf. "Monſieur *Bills* lives at preſent at *Rotterdam* in the "*Engliſh-Court* (ſo is the name of the houſe, where he lives, in *Rotterdam*.) He is a French-"man, ſpeaks French, Low Dutch, and Latin. He hath four bodies, two men and two "women, ſo anatomiſed, that he can ſhew the inward ſtate of a man's body; for all the "parts of the body are in the body, except the guts and brains, which lie by. He aſketh "above 100,000 Dutch guilders, and then he will teach the anatomy out of them to ſcholars, "ſurgeons, &c. He ſaith this coſt him not only infinite pains and head-breakings, but "that of his own patrimony he ſpent to this work 60,000 guilders. He affirms, that *Paris* "hath preſented him about 20,000 francs, and *Amſterdam* about 3000 francs for two *corpora*;

[a] General Dictionary, Vol. V. p. 126—129. [b] Hiſtory of the Reformation, Part III. B. 3. p. 417.
[c] Dated at *Wotton* in *Surrey*, Sept. 10, 1703. [d] In *Deptford*. [e] Vol. V. p. 397, 398, 399. [f] Ibid. p. 399.
[g] General Dictionary, Vol. VIII. p. 250—253. [h] See Mr. *Boyle*'s works, Vol. V. p. 292.

"but

" but he will not ſell them apart, but in that manner as I mentioned. It ſeems it is very " rare, that he anatomiſed in ſuch a manner thoſe bodies, and prepared alſo, that they can " be clearly ſeen, every thing in his proper place. The like is never yet done in this world."

DR. *John Wallis* was likewiſe a very intimate friend and correſpondent with our great philoſopher. This excellent divine and mathematician was ſon of a clergyman, and born at *Aſhford* in *Kent* on the 23d of November 1616, and about Chriſtmas 1632 ſent to *Emanuel* college in *Cambridge*, where he took the degree of maſter of arts in 1640, and about the ſame time was choſen fellow of *Queen*'s college in that univerſity, and received holy orders from Dr. *Walter Curle* biſhop of *Wincheſter*. In 1644 he was appointed one of the ſcribes or ſecretaries to the aſſembly of divines at *Weſtminſter*, being at that time miniſter of St. *Gabriel Fen-church* in *London*, whence he removed to the church of St. *Martin Ironmonger Lane*; and in 1649 was made Savilian profeſſor of geometry in the univerſity of *Oxford*; and on the 31ſt of May 1654 took the degree of doctor of divinity. February the 17th, 1657-8, he was choſen *Cuſtos Archivorum* of that univerſity; in which place, as well as in his profeſſorſhip of geometry, he was confirmed at the reſtoration, when he became chaplain to his Majeſty [a]. He died October the 8th, 1703, being eighty ſeven years, three months, and five days old, and was interred in the choir of St. *Mary*'s church in *Oxford*, where a monument is erected to his memory, though the moſt valuable one is the collection of his own writings, publiſhed together in Latin at *Oxford* in 1699, in three volumes folio. His early regard for Mr. *Boyle* is evident from his dedication to him of his book *de Cycloide & Corporibus inde genitis*, with this inſcription; *Honorabili doctiſſimoque Viro D. Roberto Boyle armigero, tum illuſtri familiâ, tum magnis virtutibus nobili*; and in his dedication he takes notice of Mr. *Boyle*'s eminent ſkill in divinity, in the ſacred and ancient, as well as modern languages, and in political and publick affairs both at home and abroad; and his inceſſant and ſucceſsful cultivation of true philoſophy by experiments of all kinds, *&c. Qui præter tuam in theologicis tum cognitionem tum praxin, atque in linguis tum ſacris antiquiſque, tum modernis etiam peritiam, in politicis item & negotiis publicis, & rerum & perſonarum, domi peregréque, intimam notitiam,*

Qui mores hominum multorum noris & urbes;

in phyſicis etiam & veræ philoſophiæ venatione ita perpetuis & ſubtiliſſimis experimentis, medicis, chemicis, anatomicis, aliiſque omne genus, naturam quaſi ferro & igne proſequaris, (nedum per omnes ſubtiliorum in quacunque arte opificum officinis) in ſecretos abditiſſimoſque ſequeris receſſus, & quaſi in viſcera penetras, ut mirum ni tibi tandem ſe in prædam dedat: quique naturam, tanquam equuleo impoſitam, ſeverâ ſaltem, ne crudeli dicam, quæſtione, torquendo vexas & retorquendo, quo verum tandem faſſa ſecreta pandat omnia: idem, in matheſi, æquationes analyticas (equuleum mathematicum) verſas, quo vix ſubtilius aliud inſtrumentum abdita perquirendi aut extricandi involuta.

IN the ſame year 1659 Mr. *Boyle* being acquainted with the circumſtances of the learned Dr. *Robert Sanderſon*, afterwards biſhop of *Lincoln*, who had loſt all his preferments on account of his attachment to the royal party, he conferred upon him an honorary ſtipend of fifty pounds a year. This ſtipend was given as an encouragement to that excellent maſter of reaſoning, to apply himſelf to the writing of *Caſes of Conſcience*, 1. " Explaining the " nature of conſcience, the obligation of it, how far that extends, and the reaſons of it, " with ſome univerſal principles and general rules concerning it, *in theſi*; and then, 2. *in hy-* " *potheſi*, to fall to the reſolving particular caſes [b]." Dr. *Sanderſon* therefore publiſhed his treatiſe, entitled, *De Obligatione Conſcientiæ Prælectiones decem, Oxonii in Scholâ Theologicâ habitæ anno Domini* 1647, and addreſſed it to Mr. *Robert Boyle* in an elaborate dedication, dated at *Boothby Pannel* in *Lincolnſhire*, November 22, 1659; wherein he ſpeaks of his patron as much more diſtinguiſhed by his excellent diſpoſitions, love of learning, humanity, piety, and all kinds of virtue, than by his birth and quality: *Cum natalium ſplendore illuſtrem, tum generoſæ mentis indole, amore literarum, humanitate, pietate, & omni virtutum genere multo etiam illuſtriorem.*

UPON the reſtoration in 1660, Mr. *Boyle* was treated with great civility and reſpect by the King as well as by the earl of *Southampton*, lord high treaſurer, and the earl of *Clarendon*, lord chancellor of *England*. And he was ſolicited by the latter to enter into holy orders, not only out of regard to him and his family, but chiefly with a view to the ſervice of the church itſelf, which could not but receive a great ſupport, as well as a powerful example, from one, who would ſoon be raiſed to one of the higheſt ſtations in it. This, as he owned to biſhop *Burnet*, made ſome impreſſion upon him. His mind was even then at three and thirty ſo entirely diſengaged from all the projects and concerns of this world, that as the proſpect of dignity in the church could not move him much, ſo the probability of his doing good in it was much the ſtronger motive. But two things determined him againſt it. One was, that his having no other intereſts with relation to religion, beſides thoſe of ſaving his own ſoul, gave him, as he thought, a more unſuſpected authority in writing or acting on that ſide. He knew, that the irreligious fortified themſelves againſt all, that was ſaid by the clergy, with this, that *it was their trade*, and that *they were paid for it*. He hoped therefore, that

[a] General Dictionary, Vol. X. p. 89—101.

[b] Dr. *Barlow*'s letter to Mr. *Boyle*, Sept. 13, 1659. Vol. V. p. 406. See likewiſe *Iſaac Walton*'s life of biſhop *Sanderſon*, and biſhop *Barlow*'s letter to *Walton*, dated at *London* May 10, 1678. and ſubjoined to *Walton*'s *life of biſhop* Sanderſon.

he might have the more influence, the leſs he ſhared in the patrimony of the church. But his main reaſon was, that he had ſo high a ſenſe of the obligations, importance, and difficulty of the paſtoral care, that he durſt not undertake it; "eſpecially, ſays biſhop *Burnet*[a], not having felt within himſelf *an inward motion to it by the holy Ghoſt*; and the firſt "queſtion, that is put to thoſe, who come to be initiated into the ſervice of the church, relating to that *motion*, he, who had not felt it, thought he durſt not make the ſtep, leſt "otherwiſe he ſhould have lied to the holy Ghoſt. So ſolemnly and ſeriouſly did he judge of "ſacred matters." He choſe therefore to purſue his philoſophical ſtudies in ſuch a manner, as might be moſt effectual for the ſupport of religion; and began to communicate to the world the fruits of thoſe ſtudies. The firſt of theſe was printed in 1660 at *Oxford*, in 8vo, under the title of *New Experiments phyſico-mechanical touching the Spring of the Air and its Effects, made for the moſt part in a new pneumatical Engine: written by way of letter to the right honourable* Charles, *lord viſcount of* Dungarvan, *eldeſt ſon to the earl of* Corke: dated at *Beconsfield* December the 20th, 1659. In this diſcourſe he diſcovered and demonſtrated the elaſtic power or ſpring of the air, and by this means exploded the notion of a *Fuga Vacui*, and ſhewed, that the ſtrange effects, which were before aſcribed to that imaginary cauſe, ariſe merely from the native ſelf-expanſion of the air. The extent of which elaſtic expanſion he found divers ways to meaſure by his engine, which likewiſe diſcovers the influence, which the air hath upon flame, ſmoke, and fire; that it hath none in magnetical operations; that it is probably greatly interſperſed in the pores of water, and compreſſed by the incumbent atmoſphere even in theſe cloſe receſſes: what operation the exſuction of the air hath on other liquors, as oil, wine, ſpirit of vinegar, milk, eggs, ſpirit of urine, ſolution of tartar, and ſpirit of wine: the gravity and expanſion of the air under water: the effect of the air in the vibrations of pendulums, and in the propagation of ſounds: that fumes and vapours aſcend by reaſon of the gravity of the ambient air, and not from their own poſitive levity: the nature of ſuction, the cauſe of filtration, and the riſing of the water in ſiphons: the nature of reſpiration, illuſtrated by trials made on ſeveral kinds of animals, and the effects of the air in the operations of corroſive liquors. However this work, which was likewiſe tranſlated into Latin, was attacked by *Franciſcus Linus* and Mr. *Thomas Hobbes* of *Malmeſbury*; which occaſioned Mr. *Boyle* to ſubjoin to a ſecond edition of it, printed at *London* 1662, in 4to. *A Defence of the Doctrine touching the Spring of the Air againſt the Objections of* Linus, *wherewith the Objector's* Funicular Hypotheſis *is examined*; *and an Examen of Mr.* Tho. Hobbes's Dialogus Phyſicus de Naturâ Aeris; *with an Appendix (Chap.* VII.) *touching Mr.* Hobbes's *Doctrine of Fluidity and Firmneſs.* The third edition of the *New Experiments Phyſico-mechanical* was printed at *London* in 1682, in 4to.

HE produced likewiſe to the world in 1660, a piece on another ſubject, which I have obſerved above to have been finiſhed as early as the year 1648, and was now printed at *London* in 8vo, and entitled, *Some Motives and Incentives to the Love of God pathetically diſcourſed of in a Letter to a Friend*, or, as it is called in the running title, *Seraphic Love.* In the *Advertiſements* prefixed to it we are informed, that this letter was not written ſingle, being but the laſt of divers, wherein love in general was confeſſed, juſtified, and celebrated; the received way of making love was explicated, defended, and oppoſed; conſtancy and inconſtancy in love were argued for and againſt; Platonic love was explicated and celebrated; the cure of love was profeſſed and proſecuted; and the controverted points concerning love were diſcourſed of in a way ſuited to the ſeveral themes, and to the humours and principles of the ſuppoſed writers. But all the former papers, drawn up in a compliment to a lady, though very free from the guilt of either licentiouſneſs or profaneneſs, were judged by Mr. *Boyle* too little ſerious, either to appear alone, or to accompany the diſcourſe publiſhed by him, wherein he had expreſſed his own opinion, as in the former he but deduced thoſe of imaginary perſons. The 9th edition of this book was publiſhed at *London* in 1708, in 8vo. It was alſo tranſlated into Latin.

AMONG the letters to him written in the year 1660, there is one dated Oct. 2. that year from Mr. *Robert Codrington*, a gentleman known by his Engliſh verſions of *Quintus Curtius*, and *Juſtin*, the Roman hiſtorian, and his other tranſlations from the Latin and other languages. In this letter he mentions his having dedicated a book to Mr. *Boyle* about ten years before, for which he had received a gratuity; and now addreſſes a Latin poem, which he intended to publiſh among the reſt of his poetical works[b].

ON the 10th of that month likewiſe Mr. *Robert Southwell*, afterwards a knight, and envoy from King *Charles* II. to the King of *Portugal*, and preſident of the Royal Society, wrote to him from *Florence*, to inform him, that the Grand Duke of *Tuſcany* was extremely deſirous of a correſpondence with him, that Prince being not only a patron of learning, but alſo a great maſter of it himſelf[c].

THE year following Mr. *Boyle* publiſhed at *London* in 4to, *Certain phyſiological Eſſays, and other Tracts*, viz. I. *Some Conſiderations touching experimental Eſſays in general.* II. *Two Eſſays concerning the Unſucceſsfulneſs of Experiments, containing divers Admonitions and Obſervations (chiefly chemical) touching that Subject.* III. *Some Specimens of an attempt to make chemical Experiments uſeful to illuſtrate the Notions of the corpuſcular Philoſophy.* IV. *A phyſico-chemical*

[a] Funeral Sermon on Mr. *Boyle*, p. 29. edit. in 4to. and memorandums dictated by Mr. *Boyle* to biſhop *Burnet* concerning his own life.

[b] Vol. V. p. 631, 632.

[c] Ibid. p. 403, 404.

Eſſay containing an Experiment, with ſome Conſiderations touching the differing Parts and Redintegration of Salt-Petre. V. *The Hiſtory of Fluidity and Firmneſs.* In the *Advertiſement to the Reader* it is obſerved, that theſe tracts were not written near about the ſame time, (ſome of them being divers years older than others,) nor were they now publiſhed in the ſame order, in which they were written. For the firſt of them, though drawn up about four years before, *viz.* in the year 1657, was not only written after the ſecond, third, and fourth, but after divers other Eſſays, which Mr. *Boyle* had then lying by him among his papers, it being intended for a kind of introduction to all thoſe treatiſes, which under ſeveral names, but chiefly that of *phyſiological Eſſays*, he had then compoſed. But having, during the confuſions before the reſtoration, ſo diſpoſed of his papers to ſecure them, that he could not himſelf ſeaſonably recover them; and being engaged by promiſe to ſome friends to let about half a dozen of his ſmall tracts come abroad into the world by ſuch a time, he was obliged to ſend them to the preſs, as they came, ſome at one time, ſome at another, to his hands. The greateſt part of them are addreſſed to his nephew Mr. *Richard Jones*, only ſon to the lord viſcount *Ranelagh* by Mr. *Boyle*'s ſiſter. In theſe *Eſſays* and *Tracts* he encourages and perſuades the making *Experiments*, and collecting *Obſervations*, and gives the neceſſary cautions, which are to be uſed in ſuch deſigns. He imparts a very conſiderable luciferous experiment concerning the different parts and redintegration of *Salt-petre*; from which he ſhews, that *motion*, *figure*, and *diſpoſition* of parts are ſufficient to produce all the *ſecundary Affections* of bodies, and conſequently that there is no need of the ſubſtantial forms and qualities of the ſchools. In the *Hiſtory of Fluidity* he ſhews, that a body ſeems to be fluid by conſiſting of corpuſcles touching one another only in ſome parts of their ſurfaces; whence, by reaſon of the numerous ſpaces between them, they eaſily glide along each other, till they meet with ſome reſiſting body, to whoſe internal ſurface they exquiſitely accommodate themſelves; and that the requiſites to fluidity are chiefly theſe; ſmallneſs of the component particles, a determinate figure of them, vacant ſpaces between them, and agitation of them variouſly and apart by their own innate motion, or by ſome thinner ſubſtance, which ſhall toſs them about in its paſſage through them. He ſhews likewiſe, how a conſiſtent body may be rendered fluid; and having illuſtrated the doctrine of fluidity by experiments, obſerves, that the reaſon, why ſome fluids will not mix with others, is their particular textures, and the peculiar motion of their minute parts. In the *Hiſtory of Firmneſs* he informs us, that firmneſs conſiſts principally in this, that the particles, which compaſs it, being ſomewhat groſs, are alſo at reſt, and have a mutual coheſion, whereby they are rendered unapt to diffuſe themſelves every way; ſo that its three principal cauſes appear to be groſſneſs, quiet contact, and implication of the component parts. He obſerves, that a juxta-poſition of parts is not the only cauſe of coheſion, but that the ſpring and weight of the air is one great cauſe; though a juxta-poſition of the parts of glaſs ſeems requiſite and ſufficient to make ſuch a compact ſubſtance, the parts of matter, which compoſe it, being firſt minutely divided by the fire before their union. He further tells us, that both the figures and textures of the parts of a body may not only contribute to their ſolidity, but that the interpoſition of the minute parts of another body may render ſome liquors ſolid, and that the addition of a powder only may make a liquor ſolid: that fluids conſiſt not of parts diviſible into fluids, as quantity into quantity: that there is a plaſtic power inherent in ſeveral bodies; and that mixture itſelf is ſufficient to produce putrefaction. Theſe Eſſays were tranſlated into Latin. The ſecond edition of them was printed at *London* 1669, in 4to, and in it ſome of the Tracts were enlarged by experiments, and an addition made to it of *A Diſcourſe about the abſolute Reſt of bodies.*

THESE *Eſſays*, together with his *New Experiments*, being ſent by Mr. *Hartlib* to Mr. *John Beale*, the latter wrote the following letter concerning them [a].

" THIS day I received the books, ſo that I cannot ſo ſuddenly give you my judgment on " them: only this I can ſay, that if an oracle had offered me my choice of what queſtions I " moſt deſired to be informed, I am well aſſured, that thoſe, that are handled by Mr. *Boyle*, " had been the very firſt matter of my election. He wants a ſpirit, that takes not pneumaticals " to be the ſpring of life, and weightieſt of naturals, and now moſt conſiderable, ſince *Jor-* " *danus Brunus* and others have inclined our modern philoſophers to approximate air to the " chief of the ambient heavens. And for my own part, I have long conceived this ambient " air to conſiſt of as many and different ingredients, as our earth or ſeas, but I never " expected in this life to ſee the diverſities ſo handled and traced out, and the properties " ſo fully diſcovered; yet this I am inforced to confeſs before I have ſeen half of the " book. In the other treatiſes I am informed of the cauſe of ſuch frequent miſconduct " in the beſt kind of medicines, and the ſtrange Protean force of ſalt-petre, and that nitre, " which is ſo highly ſtiled by ſome, as if it were the ſpirit of the world. For the Corpuſ- " cularian philoſophy, I had long ago complained to you, that Sir *Kenelm Digby* and ſome " others had ſaid enough of it to make me giddy in their *pro & contra*; and my refuge was " lord *Bacon*'s *Circa ultimates rerum fruſtranea eſt inquiſitio.* But now I ſee a ſtay for the light " of reaſon and experience. Neither had I any thing more in chace than the cauſe of *firmneſs*, " which in lord *Bacon*'s language, (who firſt awakened my attention to it,) is frequently

[a] Mr. *Hartlib* ſent a copy of that letter to Dr. *Worthington* incloſed in one from himſelf, dated Aug. 26, 1661. communicated to me by Mr. profeſſor *Ward*.

" called

" called *conſiſtency*. Being now in my devotions before the oracle, you can expect but few " lines, and in theſe my advice, that you procure them for yourſelf before they are all gone " out of the ſhops; for I ſupplicate, that theſe may rather return to you in caſh than in kind. " It is my great joy, that Mr. *B.* is ſo far engaged to give us the reſt of his Notes and follow- " ing Experiments. In theſe he hath obliged all the intelligent inhabitants of this world, " and hath given us hope, that we ſhall ſhortly complete human ſciences. Some families " amongſt us have anſwered to all lord *Bacon*'s votes for *Advancement of Learning*; and this " honourable family deſerves to be reputed the firſt college in this univerſity or oecumenical " academy."

And in another letter he wrote as follows:

" My laſt was very abrupt and conciſe, becauſe at that time, as I then told you, I was at- " tentive in my devotions before the noble oracle, which I may now, upon the reviewed ſo- " lemnities of holy oath, ſtile the moſt ſatisfying oracle in my apprehenſions, that ever ap- " peared in the converſe of mortals on this habitable globe, for the diſcovery of all the works " of nature. To thoſe, that have been ſo tired and wearied, as I have been, in the ſeveral " ways of *Toleſus*, *Flood*, *Gaſſendus*, the Carteſian, and Atomical or Corpuſcularian philoſo- " phers, and all others, that I could hear of ever ſince I was concerned in the victory of " ſchool-ſophiſters: to thoſe, I ſay, that have condeſcended to take deep notice of the " inſufficiency of language, and conjectures, and ungrounded ratiocinations, and have ſub- " mitted their patience to the ſeverity of lord *Bacon*'s inquiſitions, and, amongſt theſe, to my- " ſelf, here are offered ſuch pleaſing refreſhments, as gain us the reliſh of that *Virgilian* ſim- " plicity, which was ſo highly admired by *Scaliger* in theſe verſes;

" *Tale tuum carmen nobis, divine poeta,*
" *Quale ſopor feſſis in gramine, quale per æſtum*
" *Dulcis aquæ ſaliente ſitim reſtinguere rivo.*

" To indulge my own freedom, and a little to practiſe my pen and judgment in the impartial " collections of other men's deepeſt or moſt inticing reaſonings, I had in philoſophy and " theology reduced *Interlocutores* in the manner of *Tully*'s *Oratory* and his *Academical Queſtions*, " to offer their ſeveral ſtrengths, (as you have ſeen a ſpecimen pretending to the vindication " of a rural life,) for which academical ſcene I had long ago provided thoſe arguments in " theology, which have ſwayed no leſs men than *Grotius* and the earl of *Briſtol*, and do make " the loftieſt cedars ſtagger and revolt ſeveral ways, at as much uncertainty, as the variation of " the compaſs. And from all theſe I could procure a concurrence as to the unchangeable " oracle for a holy life. For philoſophical ſatisfactions I did chiefly addreſs to philoſophical " experiments, in which I ſeemed to have the beſt overtures of aid from lord *Bacon*; but of " this I complained, that in the progreſs of late years we had not brought his experiments, " or added our own, to any degree of ripeneſs. And this was indeed my diſcouragement. " Now I confeſs I am ſurpriſed with wonder at the preſent advancement; and I dare promiſe " our poſterity, that knowledge ſhall in this following age abound in very great perfection, " and to the beſt of noble operations. I can now no longer forbear to enquire for the return " of Mr. *Oldenburg*, which was promiſed ſome weeks ago. From him I hope to be informed, " when Mr. *Boyle* will be pleaſed to oblige the world with the publication of his other " works:

" 1. That of *promiſcuous Experiments* mentioned in the *philoſophical Eſſays*, p. 14, 15, 16.
" 2. The *Dialogues concerning Heat, Flame, and Fire*, mentioned in theſe *new Experiments*, " p. 104, 119, and 222.
" 3. The *magnetical Steams of the Earth* mentioned *ibid.* p. 120.
" 4. The *Continuation of Experiments made by the pneumatical Engine.*

" And this we may well diſcern, that nothing can drop from his pen, that doth not ob- " lige the future ages univerſally; neither can preſent envy appear againſt ſuch bright luſtre. " I pray you be mindful to lay this load upon Mr. *Oldenburg*, for it enables him to oblige us " in that ſweet entertainment of hope and expectation, which eaſeth all kinds of griefs. The " note of animals in vinegar, *Phil. Eſſays*, p. 40. may ſhew, what conſiderable uſe may yet " be made of our beſt magnifying glaſſes, if the overtures were well proſecuted."

The next work, which Mr. *Boyle* publiſhed in 1661, was his *Sceptical Chemiſt: or Chemico-phyſical Doubts and Paradoxes touching the Experiments, whereby vulgar Spagiriſts are wont to endeavour to evince their Salt, Sulphur, and Mercury, to be the true Principles of Things:* Oxford, in 8vo. To the ſecond edition, printed at *Oxford* 1679 [a], in 8vo, are ſubjoined *divers Experiments and Notes about the Producibleneſs of chemical Principles.*

In this treatiſe he obſerves, that the number of the *Peripatetic Elements* and *chemical Principles* is doubtful; and that the words *Element* and *Principle* are here uſed as equivalent terms, and ſignify thoſe primitive and ſimple bodies, of which the mixed ones are ſaid to be compoſed, and into which they are ultimately reſolved: that the matter of all bodies was originally divided into ſmall particles of different ſhapes and ſizes; and that theſe particles might

[a] The title page erroneouſly ſays 1680. See the *Advertiſement.*

unite

unite into ſmall parcels not eaſily ſeparable again: that a great variety of compounds may ariſe from a few ingredients: that various ſubſtances are obtainable from bodies by fire: that fire is not the true and genuine analyſer of bodies, ſince it does not ſeparate the principles of a body, but variouſly compounds and alters the texture of a body, which it acts upon: that ſome things obtained from a body by fire were not its proper ingredients: that all compound bodies differ only in ſome mechanical properties: that it does not appear, that three is preciſely and univerſally the number of the diſtinct ſubſtances or elements, into which all mixed bodies are reſolvable by fire: that ſome bodies afford more than three principles: that earth and water are to be reckoned among the chemical principles, and at leaſt one certain alkaline, if not alſo an acid ſpirit. He cenſures the ambiguity of the chemical writers, and ſhews, that the chemical principles are diſſimilar in their nature. He enquires, whether the five chemical principles ſhould be rejected for not being homogeneous; whence the notion of theſe principles aroſe; whether fire be neceſſary in the compoſition of bodies; and whether there be any elements at all. He ſhews, that bodies are not compoſed from all the mere elements, by the growth of bodies, vegetables, animals, minerals and metals, and the analyſis of bodies: that the *tria prima* ſeem to be the productions of fire: that neither phlegm nor earth are univerſal and pre-exiſtent ingredients of mixed bodies: that gold itſelf is deſtructible, and new qualities producible in bodies by a mere change of texture: that chemical principles are tranſmutable, as appears from the phænomena afforded by an eſſential oil in repeated diſtillations: that thoſe principles are not ingenerable and incorruptible: that ſalts may be produced and deſtroyed; and that alkalies are tranſmutable into other ſubſtances, and common ſalt, different kinds of ſpirits, ſulphurs, mercuries, phlegm, and earth are producible. He informs us, that the chemical theory of qualities is narrow, defective, and uncertain, ſuppoſing things not proved, often ſuperfluous, and frequently contradicting the phænomena of nature. That the principles found in bodies are not the cauſe of their qualities, but that contrary qualities are aſcribed to the ſame body: that, upon the whole, the chemiſt's ſalt, ſulphur, and mercury, themſelves are not the firſt and moſt ſimple principles of bodies, but rather primary concretions of corpuſcles or particles more ſimple than they, as being indued only with the firſt moſt radical and moſt univerſal properties of ſimple bodies, bulk, ſhape, motion, or reſt, by the different conventions or coalitions, of which minuteſt portions of matter are made thoſe differing concretions, which chemiſts call their principles. He then makes ſome reflections upon the hypotheſis of alkali and acid; and ſhews, that the ſuppoſition of them is precarious, their offices arbitrary, and the notion of them unſettled; that the taſte is no judge of them, and the hypotheſis of them often needleſs and inſufficient, affording but unſatisfactory ſolutions of phænomena. In a marginal note on the *Preface introductory* in the ſecond edition, he mentions ſome other *Dialogues* concerning *heat*, *fire*, *flame*, &c. which had been ſeen by two ſecretaries of the Royal Society, but were miſſing, with ſome other pieces of his, after the haſty removal of his goods by night in the great fire of *London*. This work was tranſlated into Latin.

IN 1662 a grant of the forfeited impropriations in the kingdom of *Ireland* was obtained from the King in Mr. *Boyle*'s name, though without his knowledge; for the application of which to the ſupport of religion and promotion of learning he was greatly ſolicitous, as appears from a letter of his to Dr. *Michael Boyle*, biſhop of *Corke*, dated May the 27th that year[a]; in which he mentions, that he expected from an honeſt gentleman in public employments, and very well verſed in the affairs of that country, an account, "how thoſe impro-
"priations, which are, *ſays he*, within the grant made me by his Majeſty, are, or are like to
"be, provided of miniſters and maintenance. And though the procuring me *this* account
"would, I know, require ſome time; yet the requiſiteneſs of it to aſſiſt *me*, *how* to order
"myſelf on this unhappy occaſion, made me unwilling to write to your *lordſhip*, till I had re-
"ceived it; and the adjournment of the parliament made me hope I might receive it ſeaſona-
"bly enough. But being ſurpriſed ſince the laſt poſt with the news of the parliament's being
"met again, and of the quick progreſs, that is making in the act for the ſettlement of *Ire-*
"*land*, the promiſe I made your lordſhip at our ſeparation forbids me to delay to ſay ſome-
"thing to you about the buſineſs we then diſcourſed of; but it is now too late at night, that
"I muſt not till a fitter opportunity enlarge upon particulars, but muſt make haſte to inform
"your lordſhip, that having, as I told you I intended, applied myſelf to that excellent pre-
"late the biſhop of *Lincoln*[b], for his advice on ſo nice an occaſion, I came upon the whole
"matter to this reſult, that the King's grant made to me having preceded both the grant
"made in the act to the church, and even the church's application to his Majeſty for that
"grant, I might juſtly challenge the impropriations mentioned in my proviſo. .... And
"therefore I would not have what I intend to do, reflect upon thoſe perſons of honour, that
"(though unknown to me) made uſe of my name to obtain the grant from the King; ſince
"in ſuch diſputable caſes, perſons, that act very differently from one another, may yet all
"ſatisfy their own judgments and conſciences in their proceedings. But in regard my inten-
"tion in general was to apply an addition of my revenue, if my friends procured any
"for me, to good uſes, though, I confeſs, I deſigned it rather for the advancement of real
"learning, than to any other purpoſe; yet ſince it ſo falls out, that unknown to me it is

[a] Vol. V. p. 243.

[b] Dr. *Robert Sanderſon*.

" caſt upon impropriations, it is very likely, that by the account I expect of the ſtate of " them, I may ſee cauſe to make the more immediate ſervice of religion, (by relieving the " poor in thoſe places, and contributing, if need be, towards the maintenance of miniſters " there or elſewhere, or promoting other good works, as from time to time occaſion may " require,) the principal of theſe good uſes, to which I have thoughts to apply about two " thirds of what will, *de claro*, come to me out of my ſhare of this grant, hoping alſo, that " the other perſons of honour, that are concerned in it, will have a care, that the impropria- " tions, whoſe revenues are given them, be provided with miniſters. And I ſhould poſſibly " employ the other third part alſo the ſame way, but that his Majeſty has been pleaſed, with- " out my ſeeking, or ſo much as knowledge, to appoint me governor to a corporation for " the propagating of the goſpel among the heathen natives in *New England* and other parts " of *America*. And this corporation being at great charges for neceſſary works, and eſpe- " cially for the tranſlating and printing of the Bible in the Indian tongue, above one half of " their revenue is injuriouſly detained from them by a perſon, who had ſold it to a corporation " erected for the ſame purpoſes with ours under the late uſurping powers, and now has re- " poſſeſſed himſelf of his land, becauſe thoſe, that he ſold it to, were not legally qualified " to have a ſale made to them. By which means ſo pious a deſign, as is purſued by this " corporation, is now in danger to miſcarry for want of maintenance; ſo that the work " being ſo charitable, and I having a peculiar call to promote it, I think, after having ad- " viſed with the biſhop of *Lincoln* in the caſe, that it becomes me, on ſuch a juncture of " circumſtances, to apply the other third part, or thereabouts, of what the King's grant " will yield me for ſix or ſeven years at leaſt, to the carrying on of ſo unqueſtionably " good a work; ſo that the main benefit I intend to derive from the King's bounty is the op- " portunity of doing ſome good with what, if my friends had not obtained it, might have " been begged by others, who would have otherwiſe employed it. And by this, I hope, your " lordſhip will be confirmed in the belief of what I formerly aſſured you of, namely, that " had I known, that any thing was aſked for me, whoſe grant would have been prejudicial " or unwelcome to the church, I ſhould not have conſented to have my name made uſe of " for a much greater matter, than the proviſo is like to yield me. And the ſame day your " lordſhip did me the honour to inform me of the ſtate of the caſe, I offered ſome of the " parties concerned to relinquiſh the grant, though it had already paſſed the King and coun- " cil, ſo I nor my name might have nothing to do with it; but one of the intereſted parties " being too far off to be conſulted, the proffer was declined. From all which, I hope, your " lordſhip will do me the right to conclude, that I was far from deſigning the prejudice of " the church; and that though it cannot in reaſon be expected, that I ſhould do any thing " to hinder the other perſons concerned in my proviſo to purſue the having it paſſed, and to " enjoy the benefit of it; yet I do not at all deſire, that either your lordſhip, or any other " perſon, that thinks the proviſo may be juſtly excepted againſt upon the church's behalf, " ſhould, for my ſake, at all abſtain from acting and ſpeaking, as his judgment and conſcience " ſhall direct him. For as my partners are, (and I think not cauſeleſsly) confident of being " able to carry on in *Ireland* that, which has already paſſed the ſcrutiny here; ſo, for my " part, all I pretend to by this grant is, to have the power in my own hands, to ſee, that the " proceed of it be carefully employed to the good uſes, whereto I deſign it." The biſhop of *Corke* in his anſwer to this letter of Mr. *Boyle*, dated at *Dublin* Aug. 13, 1662, obſerves [a], that with regard to the buſineſs abovementioned, he was perfectly ſatisfied, that Mr. *Boyle*'s deſign, " (if, *ſays he*, you had any, for I cannot yet imagine you to be any otherwiſe than " paſſive in the whole matter) in acquiring thoſe impropriations was charitable and religious; " for you cannot do any thing, that is otherwiſe. I muſt likewiſe very much applaud your " pious intendments for the advancement of real learning, and eſpecially for the extenſive- " neſs of your charity towards the poor Heathen natives of *New England*. But yet I muſt " humbly take leave to acknowledge myſelf unſatisfied, why that additional revenue, which " his Majeſty deſigned and promiſed for the better ſupport of the clergy here, that they may " with greater comfort attend the cures of their ſeveral churches, ſhould be diverted to any " other uſe, though in itſelf it be generous and handſom, eſpecially when I conſider, how " many congregations depend upon the ſervice of thoſe pariſhes; how deſtitute they will be " of a church to reſort unto; how the poor people will be compelled to wander through the " country, to find out an opportune place for the performance of their publick duties and de- " votions unto God. For although at preſent your piety provides all that poſſibly you may, " to prevent theſe ſad conſequences; yet you know not how they ſhall be minded, who ſuc- " ceed you; nor are you certain, that thoſe other perſons, (whoever they be,) that have ob- " tained this grant under your patronage, will be as inclinable upon that account as you are. " If they be not, (as it is great odds on your ſide againſt moſt men living,) it will not then " be unworthy your conſideration, whether ſomething of their fault will not be chargeable " upon you, by whoſe only means they were enabled to do the prejudice. As to that ad- " vice and reſolve, which was given you by that moſt excellent prelate, whoſe piety and " learning makes him deſervedly honoured by all, that have either known or read him, I " muſt neceſſarily believe it was founded on a very great miſtake. For in caſe the difference " be otherwiſe than it is ſtated in your letter, if that bleſſed Martyr *Charles* I. did in his life-

[a] Vol. V. p. 632.

" time ſolemnly devote all impropriations unto the church, that ſhould be any way inveſted " in him; if his moſt gracious Majeſty, that now is, ſhould, as an early evidence of his gra- " titude to God for his miraculous reſtoration, immediately after his acceſs into his kingdom, " engage himſelf in the like bounty to this church of *Ireland*; if his Majeſty had not only " promiſed, but actually granted them under his privy ſignet, before any conceſſion of what " your grant contains was made unto you, (whereof each particular may, as I ſuppoſe, be " made ſomewhat conſpicuous,) then certainly you will think it worthy ſome further conſi- " deration, whether you will inſiſt upon that grant or no."

MR. *Boyle*, in his letter of May 27, 1662, above-cited, mentions his having been appointed by the King governor of the *Corporation for propagating the goſpel in* New England, *and the parts adjacent in* America, and that the revenue of this corporation was injuriouſly detained from them. The caſe was this: in July 1649, there was an ordinance paſſed in the parliament, *for the promoting and propagating of the goſpel of Jeſus Chriſt in* New England, by the erecting a corporation in perpetual ſucceſſion, to be called by the name of *the preſident and ſociety for the propagation of the goſpel in* New England, " to receive and diſpoſe of monies in ſuch " manner, as ſhall beſt and principally conduce to the preaching and propagating the goſpel " amongſt the natives, and for the maintenance of ſchools and nurſeries of learning for the " education of the children of the natives; for which purpoſe a general collection was ap- " pointed to be made in and through all the counties, cities, towns, and pariſhes of *Eng-* " *land* and *Wales*, for a charitable contribution, to be as the foundation of ſo pious and great " an undertaking [a]." With the monies thus collected lands were purchaſed to the value of between five and ſix hundred pounds a year [b], and ſettled in a corporation of citizens of *London* in truſt, *Henry Aſhurſt*, Eſq; being their treaſurer. Upon the reſtoration of King *Charles* II. the corporation being dead in law, colonel *Bedingfield*, a papiſt, who had ſold an eſtate of 322 *l. per ann.* [c], which had been ſettled for the uſes of it, repoſſeſſed himſelf of it, and at the ſame time refuſed to pay back the money, which he had received for it. Mr. *Boyle* therefore uſed his intereſt with the lord chancellor *Clarendon*, to prevent that act of injuſtice; and the corporation being revived in 1661, by an expreſs charter [d], he was made governor of it, and the eſtate, which had been detained by *Bedingfield*, was reſtored to the corporation by the chancellor's decree [e].

IN 1663 the Royal Society being incorporated by King *Charles* II. by letters patents, dated the 22d of April, Mr. *Boyle* was appointed by the charter one of the council of the learned body [f]; and as he had been one of the principal perſons, to whom that Society owed its firſt riſe and progreſs, he continued during the reſt of his life one of its moſt uſeful members.

IN June the ſame year he publiſhed at *Oxford*, in 4to, *Some Conſiderations touching the Uſefulneſs of experimental natural Philoſophy, propoſed in a familiar Diſcourſe to a Friend by way of Invitation to the ſtudy of it.* The *firſt Part* contains five Eſſays: I. Of the Uſefulneſs of experimental Philoſophy, principally as it relates to the mind of man. II. Of the ſame. III. A continuation of the ſame. IV. A requiſite Digreſſion concerning thoſe, that would exclude the Deity from intermiddling with Matter. V. Wherein the Diſcourſe interrupted by the Digreſſion is reſumed and concluded. The *ſecond Part* conſiſts of two ſections; *viz.* Section I. of the Uſefulneſs to Phyſic, containing five Eſſays, *viz.* 1. Some particulars tending to ſhew its Uſefulneſs to the phyſiological Part: 2. To the pathological part of Phyſic: 3. To the ſemeiotical part of Phyſic: 4. To the hygieinal part of Phyſic: 5. To the therapeutical part of Phyſic. This book was reprinted at *Oxford*, in 4to, the year following. In the advertiſement to the reader Mr. *Boyle* obſerves, that divers parts of this work were ſent to the preſs in 1660, and 1661, as well as in 1663, and that the very laſt Eſſay of it was written ſeveral years before; ſince which time thoſe papers were left, ſometimes in the hands of friends, and ſometimes in diſtant places, where he could not come at them; a circumſtance, which he mentions, that the reader might neither wonder nor blame him, if he ſhould meet with ſome things in them, that had already been publiſhed by others, or were more vulgarly known, than his mentioning them implied; and that particularly a great portion of the *firſt Part* was written about ten or twelve years before, when he was ſcarce above twenty one or twenty two years of age.

HIS next book was *Experiments and Conſiderations touching colours: firſt occaſionally written, among ſome other Eſſays, to a Friend, and now ſuffered to come abroad as the beginning of an experimental Hiſtory of Colours.* To this were added *A ſhort Account of ſome Obſervations made by Mr.* Boyle *about a Diamond, that ſhines in the dark; firſt incloſed in a Letter written to a Friend, and now, together with it, annexed to the foregoing Treatiſe, upon the ſcore of the affinity between*

[a] Account of the Society for propagating the goſpel in foreign parts, eſtabliſhed by the royal charter of King *William* III. p. 4. edit. *London* 1706, in 4to.

[b] Mr. *Daniel Neale*'s hiſtory of *New England*, Vol. I. Chap. VI. p. 263. *who obſerves, that Mr.* Baxter *in his* Life, fol. 290. *is miſtaken in computing that purchaſe at ſeven or eight hundred pounds* per ann.

[c] *Neale, ubi ſupra.*

[d] The copy of the charter is extant among Mr. *Boyle*'s papers, and not being, as far as I can learn, hitherto printed, is inſerted in the *Appendix* to this Life.

[e] Biſhop *Burnet*'s memorandums concerning Mr. *Boyle*'s Life, and Mr. *R. Baxter*'s Funeral Sermon for *Henry Aſhurſt*, Eſq; p. 46.

[f] *Sprat*'s hiſtory of the Royal Society.

Light

Light *and* Colours: *and Obſervations made October* 27, 1663, *about Mr.* Clayton's *Diamond, and read before the Royal Society the day following.* This book was printed at *London* 1663, in 8vo, and reprinted there in 1670. It was likewiſe tranſlated into Latin. In this diſcourſe concerning *Colours*, he obſerves, that they may be conſidered either as a quality reſiding in the body, that is ſaid to be coloured, or to modify the light after ſuch or ſuch a manner; or elſe as the light itſelf, which ſo modified ſtrikes upon the organ of ſight, and ſo cauſes that ſenſation, which we call *Colour*; but that this latter is the more proper acceptation of the word *Colour*: that it is not without reaſon, that he aſcribes colour chiefly to the ſuperficial parts of bodies: and that a blind man at *Maeſtricht* in the *Low Countries* could at certain times diſtinguiſh colours by the touch of his fingers. As to particular colours, he tells us, that *whiteneſs* depends upon the roughneſs of the ſurface of the body called white, which gives it innumerable ſmall ſuperficies, which acting like ſo many *ſpecula* in various poſitions, reflect the rays of light, that fall on them, not towards one another, but externally towards the ſpectator: that blackneſs reſults from a peculiar kind of texture of the ſuperficial particles of a body, by which it damps the light, which falls on it, ſo that very little is reflected to the eye. He gives us likewiſe ſeveral experiments, which ſhew, that both black and white may be mechanically produced and deſtroyed.

He gave the public alſo the ſame year *Some Conſiderations touching the ſtyle of the holy Scriptures, extracted from ſeveral Parts of a Diſcourſe concerning divers particulars belonging to the Bible, written divers years ſince to a Friend:* London, in 8vo, and reprinted there in 1675 in the ſame form. A Latin tranſlation of it was printed at *Oxford* in 1665. The *Diſcourſe*, from which theſe *Conſiderations* were extracted, was the *Eſſay on Scripture*, of which I have given ſome account above; and it was publiſhed by Mr. (afterwards Sir) *Peter Pett*, attorney general for *Ireland*, to whom the letter of Mr. *Boyle* prefixed to it is addreſſed, and who was meant by the letters *P. P. A. G. F. J.* [a]. It was upon occaſion of theſe *Conſiderations*, that Mr. *Boyle* received from an anonymous hand the following letter.

October 26, 1665.

" Heavenly *Aretaphilus*,

" A LITTLE book, under the title of *Conſiderations on the Style of the holy Scriptures*, coming to my hands, the value your writings merit from all men, engaged me " in its peruſal; the ſympathy of which contents with my genius makes me challenge ſo near " a relation to the author, as to ſtyle myſelf his admirer. I have obſerved not only the in- " ſignificant tautology, the unpleaſant circumſtances, the inconſiderableneſs of the deſign, " and the emptineſs of the end of moſt books, which croud daily to the preſs, wreſting and " cenſuring the ſcriptures; but alſo the danger of ſeveral tenents, which the author would " make ſeem agreeable to the ſcriptures, merely to proſelyte men to their opinion, who are " apt to be in love with their rhetoric, and are thereby ſeduced to their own damnation, that " I almoſt fear to read any book with the title of holy. I preſume, if men did conſider " the weight of that text, *Whoſo adds, or diminiſheth*, &c. there would not appear ſo many " comments and large volumes in public, to confound and miſlead the multitude, who are " apt enough to ſchiſmatize, where they have a patron, *viz. Paul*, or *Apollos*, or *Cephas*, " &c. and to turn to the crooked way of deſtruction, when that little book, which affords " matter for thoſe great volumes, and points to the ſtreight path of ſalvation, is neglected, " and ſlighted. But *nitimur in vetitum*, we are too prone to forbidden cuſtoms; yet I hope this " *Enchiridion* may prove a remedy or antidote to ſome againſt the publick infection. In the " mean time I rejoice, that there is one, who has that eſteem for ſo worthy and profitable a " book as the Bible, without conſorting with men's pretended helps and additions, concluding with St. *Paul*, that it is *alone able to make the man of God perfect*. And now pardon " this trouble, and accept it, till God grant me an opportunity of a nearer conference, that " I may improve my talent of knowledge, and preſs towards the mark of all true Chriſtians.

" Yours.

" *To the honourable Mr.* Robert Boyle, *at lady*
" Ranelagh's *in* Pall-Mall, London.

In 1664 Mr. *Boyle* was elected into the company of the Royal Mines [b]; and in September that year received the following letter from *John Winthrop*, Eſq; governor of *Connecticut* and *New Haven* in *New England*:

" Honourable Sir,

" A BARK of this place meeting with one of the frigates at ſea near the port of their " arrival, I had thereby the favour of your honour's letter, and afterwards met that " gentleman Dr. *Sackvill*, recommended therein, at *Graveſant*, a ſmall town upon the weſt " end of *Long Iſland*, and had there ſome acquaintance with him. But that being a time and " place of much action, and my ſtay no longer than that the fort and town at *Manhatos*

[a] See Sir *Peter Pett*'s dedication to lord *Altham* before the Memoirs of the right honourable *Arthur* earl of *Angleſey*, edit. *London* 1693, in 8vo.

[b] Mr. *Oldenburg*'s letter to Mr. *Boyle*, dated at *London* December 10, 1664. Vol. V. p. 328.

" was reduced to his Majeſty's obedience, I could not then have much conference with him. " He abideth yet at that place, (now called *New York)* which is above a hundred miles from " my preſent habitation; but I hope there may be better opportunities, and I ſhall be ready to " do him any ſervice. After the reducing of that place, and that I ſaw it in the peaceable " poſſeſſion of his Majeſty's honourable commiſſioners, I came back towards *Hartford* to have " met the commiſſioners of the colonies there, it being their uſual appointed time, and that " the place for this year; but being taken with a fever at *New Haven* in the way homeward, I " was diſappointed of being with them at that time; but underſtanding after from thoſe, " that ſupplied in my abſence there, that there was a propoſition in your honour's letter to " them for their advice, how a great ſtock might be employed for the furthering that good " work among the Indians, although that queſtion I ſuppoſe hath been anſwered by the " commiſſioners then met; yet I am bold to add this motion, that your honour would " pleaſe to cauſe that paper, which I left with the honourable corporation in *England*, to be " reviewed. I ſuppoſe it doth give an hint of a foundation of an uſeful employ of a large " ſtock, even to thoſe good ends the corporation principally aim at. I am very deeply " obliged to your honour for multiplied favours, and in particular this of late received, of " the good advice, and intimations, and informations, in reference to thoſe matters in your " honour's letter. I do endeavour greatly to attend your commands, and to diſpoſe all people " to that duty and obſervance towards thoſe honourable commiſſioners ſent by his Majeſty, " as may teſtify their true loyalty and affection to his Majeſty, from whom they come, and " I hope for the good of theſe poor plantations. I ſhall not give your honour further trouble " at preſent, than that you will pleaſe to read, that I am in ſincerity,

" Honoured Sir,

Hartford in *New England*,
Sept. 25, 1664.

" your moſt faithful humble ſervant,

" J. WINTHROP.

THE year following Mr. *Boyle* gave the publick his *Occaſional Reflections upon ſeveral Subjects: whereto is premiſed a Diſcourſe about ſuch kind of Thoughts:* London 1665, in 8vo. reprinted in 1669, in 8vo. and tranſlated into Latin, but never publiſhed in that language. This piece was drawn up when he was very young, as appears from the following paſſage in a letter of his to his ſiſter the lady *Ranelagh*; *Nor ſhall I diſobey your threatned order for looking you out a miſlaid ſcribble I drew up* in my infancy *concerning occaſional Reflections.* And this conſideration, added to that of the cuſtom of the age, in which the imagination was more indulged upon important ſubjects, than the ſeverity of a true taſte of writing will admit, may ſerve to apologiſe for this treatiſe, againſt the inſult upon it in Dr. *Swift's pious Meditation on a Broom Staff*, who has certainly not ſhewn in that piece a juſt regard to the intereſts of religion, any more than to the character of Mr. *Boyle*, by allowing himſelf to treat ſuch ſubjects, and ſo excellent a perſon, with the moſt licentious buffoonry. The ſame year he publiſhed ſome ſmall pieces in the *Philoſophical Tranſactions*, viz. *An Account of a very monſtrous Calf*, N°. I. p. 10. together with *an Obſervation* imparted to him by Mr. *David Thomas* touching ſome particulars further conſiderable in that monſter, N°. II. p. 11. *Obſervables upon a monſtrous Head of a Colt*, N°. V. p. 85. *Some anatomical Obſervations of Milk found in Veins inſtead of Blood, and of Graſs found in the Wind-pipes of ſome Animals*, N°. VI. p. 100. *Of a place in* England, *where, without petrifying Water, Wood is turned into Stone*, Ibid. p. 101. *A further Account of an Obſervation abovementioned about white Blood*, Ibid. p. 117. But a more important work was that printed at *London* 1665, in 8vo. under the title of *New Experiments and Obſervations touching Cold; or an experimental Hiſtory of Cold begun. To which are added, an Examen of Antiperiſtaſis, and an Examen of Mr.* Hobbes's *Doctrine about Cold. Whereunto is annexed an Account of Freezing* [a] *brought into the Royal Society by the learned Dr.* C. Merret, *a fellow of it. Together with an Appendix containing ſome promiſcuous Experiments and Obſervations relating to the precedent Hiſtory of Cold.* The ſecond edition was printed at *London* 1683, in 4to. In this work he gives an account of the defectiveneſs of common weather glaſſes, the advantages of the new hermetical thermometers, and an enquiry concerning the cauſe of the condenſation of the air, and aſcent of water by cold in the ordinary weather-wiſers. But theſe are only preliminaries; for the main diſcourſe preſents us with an account, what bodies are capable of freezing others, and what of being frozen: the ways to eſtimate the degrees of coldneſs: how to meaſure the intenſeneſs of cold produced by art beyond that employed in ordinary freezing: in what proportion water will be made to ſhrink by ſnow and ſalt: how to meaſure the change produced in water between the greateſt heat of ſummer, the firſt degree of winter-cold, and the higheſt of art: how to diſcover the different degrees of coldneſs in different regions: a way of freezing without danger to the veſſel: what may be the effects of cold, as to the preſerving or deſtroying the texture of bodies: whether ſpecific virtues of plants are loſt through congelation, and then thawing: whether electrical and magnetic virtues are altered by cold: the expanſion and contraction of bodies by freezing: how they are cauſed, and how their quantity is to be meaſured: the ſtrength of water freezing, and an enquiry into the cauſe of that prodigious force: the ſphere

[a] Made in December and January 1662.

of activity of cold: how far the froſt deſcends in earth and water: an experiment ſhewing, whether cold can act through an hot medium: a way of accounting the ſolidity of ice, and the ſtrength of the adheſion of its parts: what liquors are its quickeſt diſſolvents; and an experiment of heating a cold liquor with ice. He afterwards confutes the vulgar notion of *Antiperiſtaſis*, and Mr. *Hobbes*'s Doctrine of Cold; and obſerves, that though he will not undertake to prove the nature of cold to be privative, yet he thinks it eaſy to ſhew, that the arguments produced for its being poſitive are not concluſive.

His excellent character in all reſpects had gained him ſo high an intereſt with the King, that about Auguſt the ſame year 1665, he was nominated to the provoſtſhip of *Eton* college, then vacant by the death of Dr. *John Meredith*, a poſt of great honour as well as profit. However he declined accepting it, as well becauſe he was probably apprehenſive, that the courſe of his ſtudies, to which he had ſo many years devoted himſelf, might receive ſome interruption from the duties of that poſt, as on account of his inſuperable diſinclination to entering into holy orders, which is thought neceſſary to that office [a]. But whatever other reaſons might concur with this laſt, to determine his refuſal of the provoſtſhip, the fact of his nomination to it is evident from a letter of Mr. *Oldenburg* to him, dated at *London* Auguſt the 29th, 1665 [b], in which he ſays: "If he [Dr. *John Beale*] be not miſinformed by one of his Ma-"jeſty's chaplains, who now waits at *Saliſbury* [c], and laſt week gave him a viſit, you, Sir, are "nominated provoſt of *Eton*. Which if ſo, our ſaid friend hopes, and ſo do I, you will "not refuſe it, conſidering, that that place hath many opportunities of influence on the uni-"verſities, and is able to oblige many; which ſtrengthens our hope, that you will accept of "it, eſpecially ſince it is, as I underſtand, no burthen and much accommodation, it being "alſo but half a day's journey from thence to *London*, and not much more to *Oxford*." And this is confirmed by a letter of Dr. *Beale* from *Yeovill*, Sept. 7, 1665 [d], which begins thus: *I wiſh this may find you in* Eton *college, and well ſettled there.* On the 8th of that month we find him created doctor of phyſic in that univerſity [e].

In February following Mr. *Henry Stubbe*, a phyſician at *Stratford* upon *Avon* in *Warwickſhire*, addreſſed a letter to Mr. *Boyle* upon the ſubject of the famous Mr. *Valentine Greatraks*, the Iriſh Stroker. This extraordinary perſon was ſon of *William Greatraks* of *Affane* in the county of *Waterford*, Eſq; by a daughter of Sir *Edward Harris*, Knt. one of the juſtices of the King's bench in *Ireland* in the reign of King *Charles* [f]. He was born at *Affane* on the 14th of February 1628, and educated at the free-ſchool at *Liſmore*, where he continued till he was thirteen years of age, and was deſigned the year following for the college of *Dublin*; but the rebellion breaking out in that nation, was obliged, with his mother and ſeveral other ſmall children, to fly for refuge into *England*, where they were relieved by the favour of his uncle Mr. *Edward Harris*, after whoſe death, his mother, for his further progreſs in literature, committed him to the care of Mr. *John Daniel Getſeus*, a German, who was miniſter of *Stock Gabriel* in the county of *Devon*, with whom he ſpent ſome years in ſtudying humanity and divinity. After five or ſix years abſence from his native country he returned thither, but found it in a moſt miſerable ſtate; which made him retire to the caſtle of *Caperquin*, *where I ſpent*, ſays he [g], *a year's time in contemplation, and ſaw ſo much of the madneſs and wickedneſs of the world, that my life became a burthen to me, and my ſoul was as weary of this habitation of clay, as ever the gally-ſlave was of the oar, which brought my life even to the threſhold of death, ſo that my legs had hardly ſtrength to carry my enfeebled body about.* In the year 1649 he became lieutenant in the regiment of *Roger* lord *Broghill*, afterwards earl of *Orrery*, then acting in *Munſter* againſt the Iriſh and Papiſts; and in 1656 a great part of the army there being diſbanded, and he among the reſt, he retired to his eſtate at *Affane*, and was ſoon after appointed clerk of the peace for the county of *Corke*, and regiſter for tranſplantation, and juſtice of the peace [h]. About the year 1662, *I had an impulſe*, ſays he [i], *or a ſtrange perſuaſion in my own mind, (of which I am not able to give any rational account to another) which did very frequently ſuggeſt to me, that there was beſtowed on me the gift of curing the king's evil; which, for the extraordinarineſs of it, I thought fit to conceal for ſome time; but at length I communicated this to my wife, and told her, that I did verily believe, that God had given me the bleſſing of curing the king's evil; for whether I were in private or public, ſleeping or waking, ſtill I had the ſame impulſe. But her reply to me was, that ſhe conceived this was a ſtrange imagination; but to prove the contrary, a few days after there was one* William Maher *of* Salterbridge *in the pariſh of* Liſmore, *that brought his ſon* William Maher *to my houſe, deſiring my wife to cure him, who was a perſon ready to afford her charity to her neighbours, according to her ſmall ſkill in chirurgery. On which my wife told me, there was one, that had the king's evil very grievouſly in the eyes, cheek, and throat. Whereupon I told her, that ſhe ſhould now ſee, whether this were a bare fancy or imagination, as ſhe thought it, or the dictates of God's ſpirit on my heart; and thereupon I laid my*

[a] See Dr. *John Fell*'s Life of Dr. *Richard Alleſtry*, prefixed to the Sermons of the latter, printed at *Oxford* 1684, in folio.
[b] Vol. V. p. 334.
[c] Where the King then was, on account of the plague's raging at *London*.
[d] Vol. V. p. 469.
[e] *Wood, Faſti Oxon*, Vol. II.
[f] A brief account of Mr. *Valentine Greatraks* and divers of the ſtrange cures by him lately performed, p. 15. Edit. *London* 1666, in 4to.
[g] Ibid. p. 17. [h] Ibid. p. 18, 19. [i] Ibid. p. 22.

hands on the places affected, and prayed to God for Jesus sake to heal him; and then I bid the parent two or three days afterwards to bring the child to me again, which accordingly he did, and then I saw the eye was almost quite whole, and the node, which was almost as big as a pullet's egg, was suppurated, and the throat strangely amended, and, to be brief, (to God's glory I speak it) within a month discharged itself quite, and was perfectly healed, and so continues, God be praised. His next cure was of *Margaret Mac-shane* of *Ballinecly* of the parish of *Lismore*, who had been afflicted with the evil above seven years in a much more violent degree; and soon after his fame encreasing, he cured the same disease in many other persons for three years, not meddling with any other distempers, till about the end of those three years, the ague growing epidemical, he found as formerly, that there was bestowed on him the gift of curing that disease [a]. "Within some small time after this, *continues he* [b], God was pleased by the same "or the like impulse to discover unto me, that he had given me the gift of healing; which "the morning following I told my brother and wife, but neither of them could be prevailed "with to believe it, though for my own part I had a full assurance thereof within me. "This impulse I had the sunday after Easter-day, the 2d of April 1665 early in the morning; and the wednesday ensuing I went to cornet *Dean*'s (about some occasions I had with "him) to *Lismore*, where there came into his house to me a poor man, that with a violent "pain in his loins and flank went almost double, and had also a most grievous ulcerous leg "very black, wherein were five ulcers; who desired me for God's sake, that I would lay "my hands on him, and do him what good I could. [But by the way take notice, that "as God gave me the several gifts from time to time, he always sent patients, that applied "themselves to me, for I never sought after any from the first moment to this very instant.] "Whereupon I put my hand on his loins and flank, and immediately run the pains out of "him, so that he was released, and could stand upright without the least trouble. Then "I put my hand on his ulcerous leg, (which the chirurgeons, after they had shewed all their "skill on him, told him it was perished at the bone, and so must be cut off, but that he "wanted 3*l.* to give one of them for his pains, as he informed me,) which forthwith "changed colour, and became red, and three of the five ulcers closed up, and the rest within "a few hours afterwards; so that he went out well, that could hardly by the help of his "staff crawl in, and within two days afterwards he fell to his labour, being a mason by "trade, and so continued several months afterwards to my knowledge, and to this instant, "for ought I know." The thursday following he cured col. *Phaire* of *Cahirmony* in the county of *Corke* of an ague, and afterwards many other persons of different distempers by stroking [c]; so that there was a resort to him from all parts. But being cited into the bishop's court at *Lismore*, and not producing a license for practising, he was prohibited from laying his hands on any person for the future, but still continued to do so till January 1665-6, when he came to *England* at the request of the earl of *Orrery*, in order to cure the lady of the lord viscount *Conway* of *Ragley* in *Warwickshire*, who had for many years laboured under a most violent head-ach. He staid at *Ragley* three weeks or a month; and though he failed in his endeavours to relieve that lady, he cured vast numbers of people in those parts, and at *Worcester*. He was then by his Majesty's order sent for to *Whitehall*, and continued some time in *London*, performing many remarkable cures there in the presence of persons eminent for their skill and integrity [d].

MR. *Stubbe*, who was witness to several of his cures in *Warwickshire*, published therefore at *Oxford* in 4to, a piece, entitled, *The miraculous Conformist: or, An Account of several marvellous cures performed by the stroking of the hands of Mr.* Valentine Greatarick; *with a physical Discourse thereupon, in a Letter to the honourable* Robert Boyle, *Esq*; *With a Letter relating to some other of his miraculous Cures, attested by* E. Foxcroft, *M. A. and Fellow of* King's *college in* Cambridge. Mr. *Stubbe*'s letter to Mr. *Boyle* is dated at *Stratford* upon *Avon*, February 18, 1665-6, and begins thus: "Since the best and most agreeable retribution I can make you "for the honour you do me in your remembrances, and all your other signal favours, is but "to gratify your curiosity with any remarkable intelligence, that may advance either physic "or philosophy, I shall endeavour to be as generous in my acknowledgments to you, as "you have always been in obliging me. Since my last unto you, my lord *Conway* did me "the honour particularly to invite me to his house and acquaintance, giving me withal a "fair opportunity of conversing with Mr. *Greatarick*, and beholding several of those per-"formances, the report whereof, as it gives just causes of astonishment to you, that are more "remote, so the effects fill with admiration the most learned or suspicious beholders. In "truth they are such, that he is not at all obliged to the ignorant for the esteem he hath ac-"quired, nor is it possible for the most tender or superstitious and censorious zealots to de-"stroy his repute. He is a man of a graceful personage and presence, and, if my phantasy "betrayed not my judgment, I observed in his eyes and mein a vivacity and sprightliness, "that is nothing common. As far as I could inform myself by a long and private discourse, "he is a man of a very good life, of tender and charitable principles, as extensive as the "effects of his goodness are. He professeth conforming unto the doctrine and discipline of "the church of *England*, yet without that censoriousness, whereby some signalize them-"selves. His thoughts concerning himself are modest and humble; and he presumes so well "of others, that even in some colourable circumstances he regulates his apprehensions by the

[a] Ibid. p. 22—25. [b] Ibid. p. 25. [c] Ibid. p. 25—28. [d] Ibid. p. 28—40.

" revealed mercies of God, and not the ſeverity of men. In fine, without any prejudice to " this age be it ſaid, he ſeemed to me, by his faith and by his charitableneſs, to include in " his ſoul ſome grains of the golden age, and to be a relick of thoſe times, when piety and " miracles were ſincere." The poſition, which Mr. *Stubbe* maintains in this letter, is [a], that *God had beſtowed upon Mr.* Greatrak*'s a peculiar temperament, or compoſed his body of ſome particular ferments, the effluvia whereof being introduced ſometimes by a light, ſometimes by a violent friction, ſhould reſtore the temperament of the debilitated parts, reinvigorate the blood, and diſſipate all heterogeneous ferments out of the bodies of the deceaſed, by the eyes, noſe, mouth, hand, and feet.* He then endeavours to explain the nature and manner of Mr. *Greatraks*'s working upon his patients for their cure.

BUT ſome paſſages in this letter of Mr. *Stubbe* giving offence to Mr. *Boyle*, the latter wrote, immediately upon the receipt of it, animadverſions upon it, in a letter to him, which having never been yet publiſhed, deſerves a place here from the original in his own hand-writing.

March 9, 1665-6.

" SIR,

" IT was ſo late yeſternight before I received your account of Mr. *Greatraks*'s ſtupendous " performances, that I had much ado to run it over before I went to bed; and this morn- " ing being to take care of ſome little affairs in order to a remove, that I am to make in the " afternoon for ſome days, I am obliged to anſwer your letter in as much haſte as you tell " me you writ it in; which intimation will, I hope, excuſe me to you for my not taking a " ſolemn notice of thoſe ſuperfluous acknowledgments you are pleaſed to begin with, for " ſervices, that are not conſiderable enough to deſerve or expect a public retribution, having " been but ſuch, as a leſs intereſt in the Muſes than yours would have entitled you to from " one, that is ſo much their ſervant as I.

" To begin then, I muſt confeſs to you, that I was ſomewhat ſurprized to find this epiſtle " of yours brought me from the preſs, before I had ſeen it any other way; and it is no ſmall " trouble to me, both upon your ſcore and my own, that I did not ſee the manuſcript before " it came abroad. For if I had ſeaſonably ſeen what you wrote about miracles, I ſhould " freely have diſſuaded you from publickly addreſſing to me, what I cannot but much diſſent " from; and perhaps I ſhould have been able to prevail with you to omit all that part of " your epiſtle. For beſides that ſince you take notice yourſelf of the prejudice your former Page 25. " meddling with theological matters has done you, you can ſcarce doubt, but that it has " made many perſons indiſpoſed to put the beſt conſtructions upon what you write; beſides " this, I ſay, I confeſs I think you might have ſpared ſo much pains as you take in the " former part of your letter, to ſhow, that Mr. *Greatraks*'s gift may be miraculous, ſince the " latter part of it is employed to make out what he performs by natural means. For my " part, though I be very backward to believe any ſtrange thing in particular, though but " purely natural, unleſs the teſtimonies, that recommend it, be proportionable to the extraor- " dinarineſs of the thing propoſed; yet I remember not, that I have hitherto met with (no " more than you have done) any, at leaſt any cogent proof, that miracles were to ceaſe with " the age of the apoſtles; and not only the excellent *Grotius*, but *Tertullian*, *Juſtin Martyr*, In his an- " *Cyprian*, and other ancients tell us, that the power of ejecting devils out of poſſeſſed per- notations " ſons laſted long after that, and was not unfrequent in the Chriſtian church. And therefore on the " if thoſe relations of Mr. *Greatraks*'s cures, that I have not yet ſeen, ſhall convince me, I ſhall 16th of St. *Mark*. " not ſcruple, ſince his belief and life give me no juſt ſuſpicions, to acknowledge my con- " viction, and to rejoice in the appearing of a proteſtant, that is enabled and forward to do " good in ſuch a way, eſpecially in an age, where ſo many do take upon them to deride all " that is ſupernatural; and, whilſt they loudly cry up reaſon, make no better uſe of it than " to employ it, firſt to depoſe faith, and then to ſerve their paſſions and intereſts. But by " what hitherto appears to me of Mr. *Greatraks*'s cures, I muſt take leave to think, that ei- " ther they are not real miracles; or, if they have any thing in them of a ſupernatural gift, it " is ſo far ſhort of the gifts of our Saviour Chriſt and his apoſtles, that I preſume your " friends will think, that if it were not the effect of your haſte, it was rather to ſhew your " wit than declare your opinion, that you ſeem to make a parity between them. And for " my part I ſhould in that caſe, reflecting upon the paſſage you cite, that *there are differences of* " *adminiſtrations, but the ſame Lord*, think it more fit to look upon this gift of Mr. *Greatraks*, " as a diſtinct and inferior kind, than degrade the unqueſtionable miraculous gifts of the " apoſtles, to depreſs them to the ſame level with his. For whether or no it may queſtion " the truth of his gifts being miraculous, yet certainly it will leſſen the degree of it, that " there are many diſeaſes, which he will not ſo much as meddle with; that there are others, which " he attempts to cure, but cannot; that there are others, wherein the good he does is not laſt- " ing, ſo that his patients are rather relieved than recovered; and that alſo there are others, " wherein ſo durable a contact and friction is requiſite, as makes a great reſemblance be- " twixt the operations of his hand, and the actions of phyſical agents. As to what you ſay " about *Trophimus*, whom St. *Paul* left ſick at *Miletus*, and your ſuppoſition, that he may " hence have left many ſo elſewhere; the latter part of it, if it be taken in a ſenſe pertinent " to the preſent caſe, is precarious; and as to the former, it concludes not, that St. *Paul*

[a] P. 10, 11.

" could

" could not cure him, unleſs you can make it appear, that he endeavoured it, as you confeſs
" Mr. *Greatraks* did to cure the excellent lady *Conway* and others. What you ſay, that you be-
" lieve, that there wanted not at *Corinth* thoſe, that had the gift of healing, nor an effectual
" anointing with oil; yet did the miſdemeanors of ſome draw upon ſeveral of them *irrecove-*
" *rable* (a main circumſtance, which I read not in the text) ſickneſs and death, is only affirmed.
" But if it were granted, that perſons ſo qualified were in that church, yet it will not follow,
" that they were unable to cure thoſe that died, unleſs you make it out, that they endea-
" voured it. For, to note this once for all ſuch caſes, there is no juſt cauſe to ſuppoſe, that
" God did ſo vouchſafe the gift of miracles to all, that in thoſe times had it, as that it was
" to be exerted on all occaſions; but that he, who gave it, did likewiſe by ſome way or other
" ſignify to them, when it was fit for his glory (for whoſe ſervice, and not their own or
" their friends outward advantages they were intruſted with it) that their miraculous en-
" dowments ſhould be exerciſed. And to argue from their not performing what it appears
" not that they did attempt, to their diſability to perform what they attempted, will be in-
" conſequent. St. *Peter* was able, when it was requiſite, to ſtrike *Ananias* and *Sapphira* with
" ſudden death, and St. *Paul* to ſtrike *Elymas* with blindneſs; yet theſe apoſtles never made
" uſe of this fatal power for their own or their friends defence, when they ſuffered thoſe
" rude violences, from which the exerciſe of it would in all probability have protected them.
" And our Saviour himſelf, though he could turn water into wine (as at the wedding in
" *Cana* of *Galilee*,) yet we read not, that ever he thought fit to do it but once; nor can it be
" well argued from his ſending his diſciples to buy loaves, that he was not able miraculouſly
" to multiply bread, or feed a greater number than his ordinary retinue by extraordinary
" means. As to what you ſay, that there were ſome diſeaſes, that the diſciples could not
" cure; I remember not any ſuch thing in the goſpel, unleſs you mean, as I ſuppoſe you
" may, the youth mentioned in the 17th of *Matthew*: but he, the ſtory informs us, was
" *poſſeſſed with the devil*; of which poſſeſſion the bodily diſtemper (whatever that were) was
" but an effect, and therefore in the beloved phyſician's goſpel, both the paroxyſm is de-
Luke ix. " ſcribed by *a ſpirit taketh him*, &c. and *the devil threw him down and tare him*; and in the
39. v. 42. " narrative of the cure it is ſaid, that *Jeſus rebuked the unclean ſpirit*, which in St. *Matthew*
Chap. " is called *the devil*; and is ſaid *to depart out of him*. And as to that part of this ſtory in
xvii. v. " the goſpels, that relates to the *caſting out of the devil*, I ſhall not ſpend time to diſcourſe
18. " upon it, nor to enquire what was the extent and conditions of the power Chriſt gave his
" diſciples, whilſt they were, as his uſual train, in their attendance upon himſelf; yet it
" plainly appears by their divine maſter's rebuking them in the forecited chapter of St. *Mat-*
" *thew* for their unbelief, as that, which alone had hindered the ejection of the evil ſpirit,
" that it was not want of power, but their culpable neglecting to uſe the proper means, that
" left the devil unejected. But when they were ſent forth and commiſſioned by Chriſt, not
" only we never read, that they attempted a cure, which they could not effect, but their per-
" formances were divers of them of a much higher nature than Mr. *Greatraks*'s. For not
" only *Peter* and *John* cured inſtantly a man, that had been lame from his mother's womb;
" *Peter* cured in a trice at *Lydda* one, whom the palſy had kept bed-rid eight years together;
" *Paul* in the ſame manner at *Lyſtra* made one leap and walk, that had been a cripple from
" his mother's womb; but the ſame apoſtle had ſo exuberant and diffuſive a power of chaſ-
Acts xix. " ing, not only diſeaſes, but devils, that he did it at a diſtance by the intervention of hand-
12. " kerchiefs and aprons, that were brought from his body to the ſick or poſſeſſed. To which
" I ſhould add the cures intimated to be wrought by St. *Peter*'s ſhadow, if I did not conſi-
" der, that it may be ſaid, that to come ſo near as to have that paſs over them, was to come
" within the atmoſphere (if I may ſo call it) which the efflúvia of his body made miraculouſly
" ſanative. To enumerate all the other effects of the diſciple's ſupernatural gifts would be to
" tranſcribe a good part of the Acts of the Apoſtles. And if I could imagine, that any diſ-
" cerning men were in danger of thinking, that becauſe you have made it plauſible, that
" ſome of your *Thaumaturgus*'s cures are performed by an ἰδιοσυγκρασία, or ſome kind of
" complexional efficacy, I ſhould add, that I think ſuch a ſuſpicion exceeding ill grounded,
" becauſe there are divers phænomena in the miracles of our Saviour and his apoſtles, that
" do not at all agree with ſo injurious an hypotheſis as that would be. For, to repeat no-
" thing of what I have ſaid already, our Saviour could communicate the power of working
" miracles to others at his pleaſure, (which I think you do not believe Mr. *Greatraks* can do to
" you) as in the caſe of the ſeventy diſciples; and that many years after his death, as in the caſe
" of St. *Paul*; divers of his miracles were done on abſent perſons, as that on the Centurion's
" dying ſervant and others. The mute fiſhes obeyed him, and that ſo ſtrangely, that being
" at a diſtance one of them brought St. *Peter*, not only himſelf, but a determinate piece of
" money. His power reached not only to living creatures, but inanimate ones, as the ſea
" and the wind; the former of which ſupported him when he walked on it, and both the
" former and the latter obeyed him. His power, and that of his apoſtles, (which will not,
" I ſuppoſe, be aſcribed to a peculiar temperament) reached not only to the curing of the ſick,
" but the raiſing of the dead, (which if the devil could do, he would have far more followers
" than now he has, though they be but too many) and divers of the apoſtles cures were
" done without any contact at all but barely by their word; by which alſo they could do harm
" as well as good, and bring diſeaſes and death as well as chaſe them, which will not, I pre-

" ſume, be aſcribed to an exuberance of health, (or *pluſquam perfect* tincture, as the chemiſts " ſpeak.) Beſides that, we may well be induced to believe, that even thoſe cures, wherein they " did touch the ſick, were miraculous, both by other reaſons, that may be drawn from what " has been already ſaid, and by theſe two. The one, that there is no ground to believe, " that ſo many differing and unallied perſons in one place, and at one time, ſhould have that " ſanative ἰδιοσυνκρασία, of which many ages have produced us ſo few unqueſtionable in- " ſtances, if any other than what your *Thaumaturgus*, ſuppoſing his ſuch, affords; for the teſti- " monies you cite of *Rodericus a Caſtro* are not cogent, eſpecially conſidering his religion and " that of his country; and his *creduntur* is an expreſſion, that rather argues his diffidence " than belief. And the ſecond, that the apoſtles and their contemporary workers of mira- " cles, who profeſſed themſelves ſent by God to promulgate a new doctrine, had other in- " dowments, that were confeſſedly miraculous, (and therefore needed not a complexional " phyſical power of healing) as is evident in the gift of tongues ſo illuſtriouſly poured out " on the apoſtles at the feaſt of Pentecoſt. And to this ſo much more to the ſame purpoſe " might be added, that though I have given ſome proof of my not being afraid to propoſe " paradoxes, if I think them truths, yet I ſhall clearly profeſs to you, that as much as I " aſcribe to the Corpuſcularian philoſophy, (both in my other tracts, and profeſſedly in a new " one, that this week comes out in favour of it,) I am far from believing, that any mechanical " or phyſical hypotheſis will make out thoſe ſupernatural phænomena, without having a re- " courſe to the miraculous interpoſition of God. And when I had the curioſity to conſider " the grand opinions, that are entertained among men about religion in general, I have long " looked upon thoſe enemies to Chriſtianity as none of the warieſt and formidableſt, that grant- " ing the truth of the hiſtorical part of the new teſtament, (which relates to miracles) have " gone about to give an account of it by cœleſtial influences, or natural, (though peculiar) " complexions, or ſuch conceits, which have quite loſt them, in my thoughts, the title of " knowing naturaliſts. But I muſt not forget, that the opinion I have been oppoſing may " poſſibly be diſclaimed as well by you as me, though I wiſh ſome readers do you not the " diſcourteſy to take a riſe from your epiſtle to maintain it. And by this time I preſume " you expect, that I ſhould ſay ſomething to the hiſtorical and phyſical parts of your letter, " after having inſiſted ſo long on the theological. But though to comply with that expecta- " tion and my own haſte, I ſkip other points relating to divinity, and what were not proper " for me to meddle with; yet there are two things, that I muſt not leave untaken notice of. " And firſt, as for the apology you conclude with for recommending ſome phyſical directions " after Mr. *Greatraks* ſtroking, I think moſt of your readers, eſpecially divines, will much " more eaſily forgive a phyſician the preſcribing of medicines, which is a main part of his " profeſſion, than the irreverent mention you are pleaſed to make of the language of one of " the penmen of the old teſtament, and all but one of the new; that mention neither being " required of you as a phyſician, nor appearing at all neceſſary to be made in that place; " and, but that you wrote in haſte, neither would you have publiſhed that, whereby you will " needleſsly diſpleaſe many, (and I am confident divers of your own profeſſion) nor would " you of all men have addreſſed it to me, who have publickly given cauſe to think it muſt be " peculiarly unwelcome to me. The other theological paſſage not to be overlooked is that, " which contains an opinion, which I think Chriſtianity itſelf may be ſo much concerned in, " that I cannot forbear, as I paſs along, to take ſome little notice of it, as by telling you, that " in the opinion you hold as an *undoubted truth, that God had permitted all religions to have their* " *real miracles*, I do very much diſſent from you. I have not now time to examine how far " it may be ſaid, that among a people or church, where God has already eſtabliſhed a doctrine " by divine and acknowledged miracles, and has expreſsly foretold, (or at leaſt ſufficiently " intimated) that it is poſſible he may permit ſome ſeducers to work ſtrange things to try the " people, to whom a divine doctrine atteſted by miracles has been delivered; I muſt not, I " ſay, now ſtay to examine, how far one may grant, that in ſuch a caſe, and after ſuch a " warning, falſe prophets may be permitted to work miracles; though for my part I ſee no " cogent reaſon, why the τέρατα ψευδῆ of the man of ſin may not by a conſtruction, which we " find exceeding common in Hebrew writings, be rendered (as our Engliſh tranſlation ſeems " to interpret) *falſe wonders*, i. e. miracles, that are as well falſe themſelves, as are the doctrine " they are brought to confirm. But though, as I was ſaying, I muſt not now inſiſt on a " debate of what may or may not be granted in the like caſes, that I have propoſed; yet " ſpeaking as you do indefinitely of all religions, and taking real miracles for ſuch exertions " of God's power, as are above the power of creatures, I am ſo very unapt to believe the " ſtories of the Turkiſh, Heatheniſh, and other miracles pretended to by divers enemies of " the Chriſtian religion in confirmation of theirs, and ſome enquiries I have made have ſo " confirmed me in my diffidence, that when I conſider the nature and uſe of true miracles, " (for I ſpeak not of natural prodigies, ſorceries, or impoſtures,) I confeſs I am ſo little con- " vinced, that I ought to believe the ſuſpicious and unlikely reports, that go of the miracles " of the Turks and Heathens, divers of which are ſaid to have been done in times and " places, when there were no miraculous gifts in the church to controul them, that perhaps " I ſhould not believe thoſe, that I find recorded in the ſcripture itſelf, if the relations of them " were not recommended by ſuch concurrent characters of credibility, as would make my " rejecting them an obſtinacy, and as are of another gueſs weight than thoſe, that counte-

" nance thoſe relations, whereto I do not give credit. And I little doubt, but if the pre-
" tended miracles of *Pyrrhus* and *Veſpaſian* had been watched and conſidered by Mr. *Stubbes*
" as narrowly as thoſe of Mr. *Greatraks*'s had been, you would have found at leaſt as much
" reaſon to aſcribe their cures, as his, to phyſical cauſes, if not to ſome miſtake, colluſion, or
" flattery, which the perſons, on whom thoſe wonders are fathered, render the more ſuſpi-
" cious. And though perhaps no body will more willingly grant than I, that the ſoundneſs
" of the doctrine ought to go along with thoſe miracles, that bear witneſs to religion, yet I
" doubt, whether the holineſs of doctrine, which may be allowed to ſhow, that a religion
" may be inſtituted by God, will, without the aſſiſtance of miracles, ſufficiently aſſure men,
" that it really is ſo.

" I COME now to the phyſical part of your letter, wherein many, that will diſſent from
" you about the theological, will, I preſume, confeſs, that divers things are plauſibly pro-
" poſed. And as you will believe, that I am of their mind in the general, ſo as to particu-
" lars I have not time to enter into a debate of it, eſpecially ſince you ſeem willing to refer
" that taſk to the Members of the Royal Society, who, if they think fit to meddle with it,
" are the likelieſt perſons to give a fair account of it. But in the mean while to keep ſcrib-
" ling as long as the time will permit, I ſhall briefly take notice of ſome particulars in the
" caſual order, wherein they offer themſelves to my thoughts, premiſing only in general,
" that you write to one, that is almoſt as backward to acquieſce in the explications of ſtrange
" things, as to believe the narratives.

" I AM not yet fully convinced, that there is in what either you or the ingenious Mr. *Fox-*
" *croft* relate upon your own obſervations, (of which in this whole letter I do upon your
" teſtimony ſuppoſe the truth) any thing, that is purely ſupernatural, (unleſs in the way, wherein
" he was made to take notice of his gift, and exerciſe it, there may be ſomething of that
" kind ;) and therefore till the contrary doth appear, I hold it not unlawful to endeavour to
" give a phyſical account of his cures, and to enquire, whether his touch be any more than
" a more noble ſpecifick, that reaches not to all diſeaſes, or to moſt, but to more than the
" generality of ſpecificks, whoſe operations are uſually more confined.

" THOSE phyſicians, and other learned men, that think every diſeaſe muſt be overcome by
" diſtinct and appropriated remedies, that are contrary to the particular diſeaſe upon the ac-
" count of ſome known quality, as that a fever being a diſeaſe hot and dry muſt be cured by
" remedies cold and moiſt, will perhaps think it incredible, that the application of one thing
" ſhould work ſo many differing effects, and cure ſo many differing diſtempers. But though
" I think it is ſtrange and extraordinary, yet I dare not ſay it is impoſſible to mere nature.
" This would be ſufficiently manifeſted, if the relations, that *Helmont* makes of the various
" and ſudden cures he ſaw performed by *Butler*'s drif, either touched with the tip of the
" tongue, or by outward application, were proper to be urged on this occaſion. But with-
" out having recourſe to them, the ſtrangeneſs may be leſſened, if we conſider theſe two
" things ; the one, that diſeaſes are not always ſo differing in their nature and eſſence as they
" are commonly thought, but the ſame morbifick matter for eſſence may produce very dif-
" fering ſymptoms, which may be taken for ſeveral diſeaſes, according to the condition of
" the parts, that it reſides in, or works upon, (in all or moſt of which it may be ſubdued by the
" ſame remedies, which may deſtroy its texture, giving it a more innocent one, or proſcribe
" it) as we ſee in ſome metaſtaſes of the morbific matter, which according as it ſucceſſively
" affect differing parts has the appearance of ſeveral diſeaſes, as in ſome of the inſtances you
" give, and in hyſterical fits, which ſometimes counterfeit almoſt all diſeaſes, and in other
" examples, which I have elſewhere taken notice of. The other, that ſome remedies are of
" that noble nature, that their efficacy reaches to diſeaſes, that ſeem of contrary kinds, as may
" be ſeen in the operations of the *Spa* waters, and thoſe which I have in ſome lucky ſeaſons
" obſerved at our own wells near *Tunbridge* ; and we ſee how many differing diſeaſes are cured
Hippro- " by an excellent air, which keeps me from wondering at that ſentence of *Hippocrates*, γῆν
catis, Lib. " μεταμείβειν ξύμφορον ἐπὶ τοῖσι μακροῖσι νοσήμασι.
tertii, " As to what ſeems your main hypotheſis, that Mr. *Greatraks* performs his cures by the
Sect. 5ta " ſtrengthning and reinvigorating of nature, which being relieved and fortified by the ſana-
Popular. " tive effluvia, that paſs from his body into the body of the patient, doth afterwards vanquiſh
" the diſeaſe herſelf, I doubt not, that you will have many of your readers of that opinion
" with you ; and particularly thoſe Helmontians and other chemiſts, that hope or plead for
" univerſal medicines, operating by way of reſtoratives, will be glad to find you to counte-
" nance their tenet. For my part, unleſs I could ſend you what I once drew up by way of
" diſquiſition about the received notion of nature, (wherein perhaps I do not acquieſce,) I
" cannot think it proper to mention to you my particular thoughts of the power of ſtrength-
" ened nature. But ſome ſcrupulous perſon will not only deny, that nature alone, though
" fortified with any thing, that is but a cordial, can cure all diſeaſes, (as for inſtance, the
" ſtone in the bladder, or kidneys, when it is confirmed and grown too big to be voided by
" the urinary paſſages) but will perhaps enquire, whether it does appear, that Mr. *Greatraks*'s
" touch is poſitively a cordial, and not barely or chiefly ſo, as it relieves nature by freeing
" her from ſome diſtempers, that oppreſſed her, as when burned feathers remove the faintings
" of hyſterical women, and others are freed from lypothymia's by being pinched, or having
" cold water thrown on their faces. But theſe ſcrupulous perſons, (if you meet with any

" ſuch,)

" ſuch,) will perhaps be more eaſily ſatisfied in other caſes than about the cure of wens. " For whereas Mr. *Greatraks*'s touch muſt, according to the forementioned hypotheſis, free " the patient from them, by invigorating nature, and enabling her to diſcuſs or preſcribe " thoſe preternatural collections of matter; I muſt inform you, that to omit *Helmont*'s ſtory, " I was the other day viſited by an eminent phyſician, who not long ſince upon occaſion of " a fine pendulum clock, that I was taking notice of in his chamber, told me, that it was " preſented him by ſuch a one, (a well known perſon, that has the honour to be one of his " Majeſty's domeſticks) for having cured his daughter of an almoſt monſtrous wen by the " laſting application of a dead man's hand. And ſuch another cure of a wen, or ſome ſuch " tumour, I remember our famous *Harvey* related to me as performed (if I very much " miſtake not) by himſelf, by ſtroking the wen, as *Helmont* preſcribes, with a dead man's " hand. But this advantage you have, that however it will perhaps be very difficult for thoſe, " that upon theſe, and the like grounds, do reject the ſtrengthning of nature, to pitch, " among the hypotheſes, that are yet noted, upon a more plauſible one, eſpecially ſince " your great *Hippocrates* is ſuppoſed to be of the like opinion when he pronounced that " ſentence, Νοσῶν φύσεις ἰητροί. But I hope you will allow me to add (what if I forget not " you yourſelf ſome where ſeem to intimate) that Mr. *Greatraks*'s touch may work not " only as a cordial or ſtrengthner of nature, but as a proper remedy of qualities oppoſite to " thoſe of the cauſes of the diſeaſes he cures. For I do not ſee, why it may not be poſſible " for the ſanative, and perhaps anodyne ſteams of his body to be of ſuch a texture, that " they may both reinvigorate the ſpirits, and by appropriated qualities oppoſe and ſubdue " the morbific matter or ferment, as we ſee, that lemons (to name no other things) have, " beſides their cordial virtues, the power to cool, incide, and reſiſt putrefaction, and " ſtrengthen the ſtomach, and promote urine, *&c.* And when I conſider the ſtrange effects, " that longing has produced in teeming women, and the ſudden and manifeſt operations I " have ſometimes known paſſions to have upon the body, I am not ſure, but that ſomething " elſe may be fit to be taken into conſideration about Mr. *Greatraks*'s cures; and that in " ſome of his patients the mind by exalted imagination, and by ſtrong paſſions, (which in " ſo extraordinary and ſuppoſedly ſupernatural as well as publick way of healing as his, " there are ſeveral circumſtances, that may heighten) may have an intereſt in the recovery, " by occaſioning uſually a great and therefore probably ſometimes a lucky commotion in the " blood and ſpirits, upon whoſe motion (and thereby texture) thus altered, that the amend- " ment, if not recovery, may ſometimes enſue, the obvious, though unheeded inſtances of " thoſe, that are freed from the hiccough, by being told of ſome feigned ill news, or even of " ſome other thing, that but excites a great attention of mind, and much more the exam- " ples, that have been divers times ſeen of diſeaſes frighted, or by fits of paſſion driven away, " make me think it not abſurd to ſuſpect.

" WHAT you mention of morbific ferments, I know divers ingenious readers will approve, " and they ſeem to be of good uſe in the explication of diſeaſes. But whether all diſeaſes " require ferments; and whether your doctrine about them be as well applicable to the reſt, " as to ſome, is a diſquiſition, that I ſhall willingly leave to thoſe learned men of your fa- " culty, that our age and country abounds with.

" WHAT you mention of Mr. *Greatraks*'s exciſion of wens and immediately ſtanching " the blood, as it much takes off from the appearance of a miracle, ſo as to the phyſical " cauſe of it, it may or may not have a great deal of difficulty, according to ſome circum- " ſtances, which I would gladly be informed of. For if the wen be ſuch, or ſo placed, " that it being cut out by a chirurgeon, no ſuch veſſels would be cut as that, according to the " common courſe of nature, the effuſion of blood would be great, it is no great wonder it " ſhould ſtop after the application of his finger, that perhaps compreſſes the orifice of the " veſſels; and the marvel is confined to the ſudden ceſſation of the pain, which may be at- " tributed to ſome anodyne effluvia iſſuing from his hand. But if in the extirpating of the " wen any great veſſels be cut aſunder, the ſtanching of the blood ſeems to be more diffi- " cult to be accounted for by ſuppoſing with you, that his cures are performed by reſtoring " the temperament of the debilitated parts, and reinvigorating the blood. For though this " be granted, it will not be ſo clear, that the blood ſhould by his touch be ſo quickly " ſtanched, ſince in a perſon, that were perfectly healthy, and where the blood needed no " invigoration, upon ſuch a ſolution of continuity there would be a large effuſion of the " continually circulating blood, unleſs appropriated means be uſed to ſtay it, as is daily ſeen " in the wounds received by healthy men. The obſervation of ſtanching of blood out of " *Platerus* I well remember, as having had occaſion to make uſe of it, together with an " experiment of his own, that he annexes to it, of a perſon, that he himſelf cured by the " ſame means. But I doubt, whether theſe will reach your caſe, till you have made out the " cauſe of this operation. For, that there may be very differing applications, that will " ſtanch blood, may be learned from him in the ſame place, where he relates how he made a " chirurgeon ſtanch a dangerous hæmorrhage, not by the application of a bloody part of a " hen, but of aqua fortis, which is corroſive inſtead of being balſamical. If indeed there " be any truth in the ſtrange relations I have met with in ſome navigators of an Indian ſim- " ple, that worn by a great commander, kept his wounds from bleeding, (which what I elſe- " where mention of the effect of the moſs of a dead man's ſkull upon a noble friend of

" mine,

" mine, does, though not approach, make the leſs incredible) it may be more plauſibly " argued, that Mr. *Greatraks*'s finger may in this caſe operate as a natural agent; but then " there will remain ſome little ſcruple, whether the effect be wrought in the particular way " you ſeem to pitch upon, till it appears, that theſe things work either as reſtorers of nature, " or as balſams, and not rather as medicines (by ſome hidden virtue) appropriated to ſuch " particular effects, which ſeems to be the caſe of the moſs of dead men ſkulls, and the " holding of ſpiders to the noſe of bleeding perſons. But perhaps a fuller information of " circumſtances will eaſe me of this ſcruple, and therefore I ſhall not inſiſt upon it.

" WHAT you ſay of the ſubtlety of the effluvia, and of the great efficacy they are capable " of, will not be much ſtruck at by a Corpuſcularian. And if I could think it proper here " to add ſome of the inſtances of that kind, which I have lying by me in my notes about " Occult Qualities, (as they are commonly called) perhaps they would afford no deſpicable " confirmation both to what you here ſay, and to what I have elſewhere written about the " power of inviſible corpuſcles. And I am the more perſuaded to think great matters per- " formable by them, both by ſome odd obſervations, that I have ſince met with of the effi- " cacy of the even ſolid parts of dead animals, and particularly of a ſea-horſe tooth out- " wardly applied to the body; and by conſidering, that a ſanative temperament may reaſo- " nably be ſuppoſed capable of diffuſing its virtue by contacts more plentifully and more " powerfully in a living body of a ſanguine complexion, where the natural heat of the blood " and ſpirits, being vegete and active, inceſſantly emit ſo great a plenty of inſinuating ſteams, " as living bodies, that tranſpire freely, appear to do by the notable obſervations of *Sanctо-* " *rius*'s ingenious *Medicina Statica*, (not to mention my own trials to the ſame purpoſe.) " I will only add in favour of the efficacy of ſteams, that I have ſeveral times made a ſlight " preparation of ſal armoniac, (that I have imparted to divers ingenious men) by the odour " of which more than once or twice, ſome, that have ſuddenly fallen down and were taken " for epileptick, have been in a few minutes, after I had held a ſmall viol under their noſes, " brought to themſelves again; hyſterical vapours, and ſome painful dulneſſes of the head, " have been often, as the patients aſſured me, diſſipated for the time in a trice; and there " are at leaſt two or three able phyſicians, (whereof but one is unknown to you) who will " aſſure you, they have (though not conſtantly) preſently cured the tooth-ach by the ſteams of " that ſame preparation of ſal armoniac, which they were pleaſed to ſend to me for; and of " which, if I had time, I could tell you ſome other feats wrought without the contact of the " viſible body.

" As to what you ſay about the poſſibility of freeing patients from the morbifick mat- " ter, (whoſe bulk oftentimes is not near ſo great as the miſchief it does) without purging, " vomiting, and the like evacuations; I am glad to be able to confirm by your teſtimony " what I ventured to publiſh about three years ſince to the ſame purpoſe, where I endea- " voured to bring ſpecificks out of the diſeſteem of a ſort of learned phyſicians of a neigh- " bouring country, that were very ſevere to them; and where I remember I attempted to " confirm the opinion you now defend, by the inſtances, among others, of thoſe, that are " cured of agues and other diſeaſes by ſudden frights, where there uſually intervenes no ſen- " ſible evacuation of peccant matter.

" WHAT you teach, that as to the pains and diſtempers, that are thought to fly from him " from one part of the body to another, they avoid not his hand; but his touch and ſtroke " ſo invigorateth the parts, that they reject the heterogeneous ferment, till it be expelled the " body at ſome of thoſe parts he is thought to ſtroke it out at, is a handſom conjecture, " and agrees very well with your hypotheſis. But I perceive by your way of mentioning " ſimilar attraction, you are (and that very juſtly) diffident of its being granted you by me, " who am, I confeſs, very ſhy of admitting any thing as a principle in matters purely phy- " ſical, that I cannot well underſtand, and do not find well proved. But you are freed from " further effects of my ſcrupulouſneſs, by my being called upon by the late time of the day " to take horſe, I ſhall not make you any apology for taking the ſame liberty to diſſent " from you in ſome points, that you took in propoſing thoſe opinions to me, which the " knowledge of my principles might eaſily make you think I would diſſent from. And " ſince both your letter and this anſwer are written in haſte, as I am willing, that my haſte " ſhould be my excuſe for any thing, that the leiſure of reading over your letter a ſecond " time, and of reviewing what I have confuſedly ſcribbled might have made me avoid or " mend; ſo I would not be ſo unkind to you as to impute to your deſign, whatever ſome " critical readers may plauſibly enough infer to the prejudice of religion from ſome unſtu- " died expreſſions of your *raptim ſcripta*; nor ſhall I take them for your deliberate tenets, " unleſs upon a review you ſhould ſurpriſe me with declaring them to be ſo; but am very " willing to leave you the liberty of explaining yourſelf in any thing, wherein the impetus " you tell me you writ with, may have had an influence on your pen. And as for the phy- " ſiological part of my letter, though I have annexed it, leſt you ſhould in vain expect " ſome of my thoughts of the phyſical part of yours; yet not having a competent know- " ledge of the matters of fact to ground an hypotheſis upon, I have been obliged, for want " of ſuch an information, and out of an unwillingneſs either to ſay nothing to you or ſpeak " raſhly, rather to diſcourſe on ſome paſſages of your epiſtle, than to eſtabliſh any theory " about the thing itſelf, which future relations may oblige me to alter. And therefore as I

" propoſe my ſudden apprehenſions but as conjectures, that amount not to an opinion, ſo I " ſhall not be concerned, eſpecially being otherwiſe ſufficiently buſied, to contend for them. " And I the more willingly ſuffer my occaſions to keep me from troubling you with any " more of theſe phyſical diſcourſes, becauſe you have in ſome ſort addreſſed your letter to " the highly learned Dr. *Willis*, from whoſe profeſſion and abilities you may expect a better " account of what is like to be applauded or queſtioned in the phyſical paſſages of your let- " ter, than from him, whoſe parting haſte obliges him to leave the hiſtorical part untaken " notice of, ſave by his wonder at it, and thanks for it, and to ſubſcribe himſelf ſomewhat " abruptly,

" Sir, your very humble ſervant."

AT the end of the original of this letter of Mr. *Boyle*, I find in his hand-writing an account of ſome cures performed in his preſence in April 1666, by Mr. *Greatraks*, who in the month preceding had been very ſeverely attacked in a pamphlet, ſuppoſed to be written by Mr. *David Lloyd*, reader of the *Charter-houſe*, and printed in 4to under the title of *Wonders no Miracles: or Mr.* Valentine Greatrates's *Gift of healing examined, upon occaſion of a ſad Effect of his ſtroking, March the 7th, 1665, at one Mr.* Creſſet's *houſe in* Charter-houſe-yard. *In a letter to a reverend divine living near that place.* This letter is dated March the 13th, 1665-6, and obliged Mr. *Greatraks* to vindicate himſelf from the imputation caſt upon him in it by publiſhing at *London* in 1666, in 4to, *A brief Account of Mr.* Valentine Greatraks, *and divers of the ſtrange cures by him lately performed. Written by himſelf in a Letter addreſſed to the honourable* Robert Boyle, *Eſq; Whereunto are annexed the Teſtimonials of ſeveral eminent and worthy perſons of the chief Matters of Fact therein related.* In this letter, which is dated at *London* May the 8th, 1666, he obſerves, that though he had not the happineſs formerly to have an acquaintance with Mr. *Boyle*, *yet I was*, ſays he, *no ſtranger to your worth and virtue, which have made you as much admired and reverenced abroad, as honoured and beloved at home. And therefore I have aſſumed the confidence to make this addreſs to your honour, whoſe repute and teſtimony to the world will be ſo powerful (knowing your wiſdom, devotion, and learning to be ſo great,) that truth may find belief, God have glory, and his poor inſtrument be juſtified before men, who hath no further deſign in the diſtribution of that talent, which the all-healing God has intruſted him withal, than the honour of his Maker, and the good of his poor fellow-creatures, whoſe diſtempers, many of them, neither art nor phyſic probably could reach.* At the concluſion he intimates his deſign, when he had an opportunity, to anſwer all the queries, which Mr. *Boyle* had put to him in a paper delivered into his hands, and which he was not then at leiſure to ſatisfy. The teſtimonials ſubjoined to this letter are ſigned, among others, by Mr. *Boyle* himſelf, *William Denton*, M. D. *James Faireclough*, M. D. Sir *William Smith*, Bart. Sir *Nathaniel Hobart*, Knt. and Maſter in Chancery, Sir *John Godolphin*, Knt. *Albert Otto Faber*, M. D. Col. *Geo. Weldon*, *William Knight*, alderman of the city of *London*, Sir *Charles Doe*, Sir *Abraham Culler*, Bart. *John Wilkins*, D. D. afterwards biſhop of *Cheſter*, *Benjamin Whichcot*, D. D. *Ralph Cudworth*, D. D. *George Ruſt*, D. D. and dean of *Connor*, *Simon Patrick*, afterwards biſhop of *Ely*, &c. ſeveral of whom give the higheſt character of Mr. *Greatraks*'s integrity and unblameable converſation in every reſpect.

IN the ſame year, 1666, Dr. *John Wallis* addreſſed to Mr. *Boyle* an *Hypotheſis about the Flux and Reflux of the Sea*, by way of letter dated from *Oxford*, April 25, and printed in the *Philoſophical Tranſactions*, N°. XVI. p. 264. which begins thus: " You were earneſt with me, when " you laſt went from hence, that I would put in writing ſomewhat of that, which at divers " times theſe three or four years laſt paſt I have been diſcourſing with yourſelf and others " concerning the *common Centre of Gravity of the Earth and Moon*, in order to ſolving the " phænomena, as well of the ſeas ebbing and flowing, as of ſome perplexities in aſtronomical " obſervations of the places of the cœleſtial bodies. How much the world, and the great " bodies therein, are managed according to the laws of motion and ſtatic principles, and " with how much of clearneſs and ſatisfaction many of the more abſtruſe phænomena have " been ſolved on ſuch principles within this laſt century of years, than formerly they had " been, I need not diſcourſe to you, who are well verſed in it. For ſince that *Galileo*, and " after him *Torricellio*, and others, have applied mechanic principles to the ſolving of philo- " ſophical difficulties, natural philoſophy is well known to have been rendered more intelli- " gible, and to have made a much greater progreſs in leſs than an hundred years, than before " for many ages."

DR. *Thomas Sydenham* likewiſe dedicated to him that year his *Methodus curandi Febres propriis obſervationibus ſuperſtructa*, printed at *London* in 8vo. This piece being very ſcarce, though a ſecond edition of it appeared in 1668, and it not being reprinted among that great phyſician's works, I ſhall tranſcribe ſome paſſages of the dedication, which places Mr. *Boyle*'s character in a very amiable light, and informs us, that he uſed to attend Dr. *Sydenham* in viſiting many of his patients.

Illuſtriſſimo & excellentiſſimo Domino, Domino ROBERTO BOYLE.

" Uſque adeo bonorum doctorumque animos, quicquid ad te, vir undiquaque nobiliſſime, quoquomodo pertinere conſpicitur, attentos reddit & experrectos, ut eos prævideam ſtatim

" cognoſcendi avidos, quibus demum fretus rationibus nominis tui longè celeberrimi authori-
" tatem ad hujuſce operis patrocinium aſciſcere ſuſtinuerim. Quid plerique in ſimili negotio
" pro more cauſari ſoleant, me neutiquam fugit. Eſt ſanè, quod ego (perinde ac faciunt alii) de
" multis magniſque tuis erga me meritis palam populo commentari poſſem; atque etiam grati
" animi ſpecimen daturus, honoris ac cultûs, quo te proſequor, duraturum aliquod monu-
" mentum, multo verborum apparatu, architectari. Atqui ejuſmodi conſilium (ut liberè pro-
" fiteor) in te tam præſidenter interpellando ab animo meo procul abfuit. In immenſas laudes
" tuas deſcendere non inſtitui, aut eximias animi dotes, quibus decantatiſſima anteriorum
" ætatum nomina unus exæquas, (uberrimam ſane tum mihimet ipſi, tum operi meo quali-
" cunque honorificam præfandi materiam) ediſſerere. Enimverò id ipſum tractatus à te jam-
" pridem in lucem emiſſi pleniſſimè loquuntur; nec alio tibi opus futurum eſt præcone, cujus
" ſubſidiaria vox nominis tui claritatem amplificare ſatagat. Quocirca tritis hiſce jamque tra-
" latitiis præfandi argumentis ultro repudiatis, me tractatum hunc ideo in clientelam tuam
" dediſſe profiteor, propterea quod, quemadmodum ego tuo ſuaſu atque inſtinctu hanc pro-
" vinciam ſuſcepi, ita etiam eorum, quæ hic traduntur, veritatem & efficaciam tute ipſe,
" teſtis planè locupletiſſimus, experientiâ aliquoties comprobatam conſpexiſti, dum ad illud
" obſequii identidem deſcenderis, (quæ tua & quidem egregia eſt humanitas) ut temet in ade-
" undis ægris meis comitem mihi adjungeres; in quâ ſanè re benignum animi affectum ad
" honeſta utcunque ſe demittentem, vel invito hujuſce ſæculi genio, oſtendiſti."

THE ſame year Mr. *Boyle* publiſhed at *London* in 8vo, his *Hydroſtatical Paradoxes made out by new Experiments, for the moſt part phyſical and eaſy*; which had been preſented to the Royal Society, at whoſe requeſt they had been made in May 1664. In this book, which was publiſhed likewiſe in Latin, he ſhews, that the lower parts of fluids are preſſed by the upper: that a lighter may gravitate upon one, that is more ponderous: that if a body contiguous to it be lower than the higheſt level of the water, the lower end of the body will be preſſed upwards by the water beneath: that the weight of an external fluid is ſufficient to raiſe the water in pumps: that the preſſure of an external fluid is able to keep an heterogeneous liquor ſuſpended at the ſame height in ſeveral pipes, though they are of different diameters: that when a body under water hath its upper ſurface parallel to the horizon, the direct preſſure it ſuſtains is no more than that of a column of water, which hath the abovementioned horizontal ſuperficies for its baſis; and if the incumbent water be contained in pipes open at both ends, the preſſure is to be eſtimated by the weight of a pillar of water, the baſis of which is equal to the lower orifice of the pipe (parallel to the horizon,) and its height equal to a perpendicular, reaching to the top of the water, though the pipe be much inclined, irregularly ſhaped, and in ſome parts broader than the orifice: that a body in a fluid ſuſtains a lateral preſſure from it, which increaſes in proportion to the depth of the immerſed body in the fluid: that water may be able to depreſs a body lighter than itſelf: that a parcel of oil lighter than water may be kept from aſcending in it: that the cauſe of aſcenſion of water in ſiphons may be explained without the notion of *abhorrence* of a *vacuum*: that the heavieſt body known will not ſink of itſelf, without the aſſiſtance of the weight of the water upon it, when it is at a depth greater than twenty times its own thickneſs, though it will nearer the ſurface.

HIS *Origin of Forms and Qualities, according to the Corpuſcular Philoſophy, illuſtrated by Conſiderations and Experiments: written formerly by way of Notes upon an Eſſay about Nitre*, was printed likewiſe in 1666 at *Oxford*, in 4to, and reprinted the year following in 8vo, with the addition of a *Diſcourſe of ſubordinate Forms*. In his *Origin of Forms* he delivers the minds of men from the imaginary and uſeleſs notions of the ſchools about them, which have no foundation in the nature of things, nor in the leaſt promote knowledge, or aſſiſt mankind; but very much diſſerve thoſe great intereſts, by ſetting the underſtanding at reſt in general obſcurities, or employing it in aiery ſubtilties and diſputes, and ſo hindering its purſuit of particular cauſes and experimental realities. He lays down the foundations, and delivers the principles of the mechanic philoſophy, which he confirms and illuſtrates by ſeveral agreeable and inſtructive experiments. He ſhews, that the moſt admirable things, which have been taken for the effects of *ſubſtantial Forms*, and are uſed as proofs of notional hypotheſes, may be the reſults of the mere texture and poſition of parts; ſince art is able to make vitriol, as well as nature, and bodies may be produced by human ſkill, the ſuppoſed forms of which have been deſtroyed. He gives us many very ingenious inſtances to prove, that the mechanic motions and order of the parts is ſufficient to yield an account of the difference of bodies, and their affections, without having recourſe to the forms and qualities of the ſchools; as in the reſtoration of camphire to its former ſmell and nature, after its diſſolution and ſeeming extinction; in the changes of the colour, conſiſtence, fuſibleneſs, and other qualities of ſilver and copper; in the odd phænomena of a certain anomalous ſalt, and thoſe of the ſea-ſalt, dried, powdered, and mixed with aqua fortis; and in the ſal mirabilis, in the production of ſilver out of gold by his *menſtruum peracutum*, in the tranſmutation of water into earth in a certain diſtillation of ſpirit of wine and oil of vitriol: in ſhort, he makes it evident, that the internal motions, configuration, and poſition of the parts, are all that is neceſſary for alterations and diverſities of bodies; and conſequently, that ſubſtantial forms and real qualities are needleſs and precarious beings.

HE communicated alſo to Mr. *Oldenburgh* ſeveral pieces, which were publiſhed in 1666 in the *Philoſophical Tranſactions*, viz. *A Confirmation of the former Account*, [*Phil. Tranſ.* N°. X. p. 166.] *touching the late Earthquake near* Oxford, *and the Concomitants thereof:* N°. XI. p. 179. *Some Obſervations and Directions about the Barometer:* p. 181. *General Heads for a Natural Hiſtory of a Country, great or ſmall:* p. 186. *A way of preſerving Birds taken out of the Egg, and other ſmall Fœtus's:* N°. XII. p. 199. *An Account of a new kind of Baroſcope, which may be called Statical, and of ſome Advantages and Conveniences it hath above the Mercurial:* N°. XIV. p. 256. *A new frigorific Experiment, ſhewing how a conſiderable degree of cold may be ſuddenly produced without the help of ſnow, ice, hail, wind, or nitre; and that at any time of the year:* N°. XV. p. 256. *Other Inquiries concerning the Sea:* N°. XVIII. p. 315. *Promiſcuous Inquiries about Mines:* p. 334. *The Method obſerved by Dr.* Lower *in transfuſing* the blood of one live animal into another: *N°. XX. p.* 353. *Trials propoſed to Dr.* Lower, *to be made by him for the improvement of transfuſing blood out of one live animal into another:* N°. XXII. p. 385. *Propoſals to try the effect of the pneumatical Engine exhauſted, in plants, ſeeds, eggs of ſilk-worms:* N° XXIII. p. 424.

IN 1667 he publiſhed in the ſame *Tranſactions*, *A Confirmation of the Experiments mentioned in* N°. XXVII. *to have been made by Seignor* Fracaſſati *in* Italy, *by injecting acid liquors into the blood:* N°. XXIX. p. 551. *New Experiments concerning the relation between Light and Air in ſhining Wood and Fiſh*, N°. XXXI. p. 581. And *Obſervations and Trials about the Reſemblances and Differences between burning Coal and ſhining Wood*, N°. XXXII. p. 605.

THE ſame year Dr. *Walter Needham* dedicated to him his *Diſquiſitio Anatomica de formato Fœtu*, printed at *London* in 8vo, with this inſcription: *Nobiliſſimo, clariſſimo* Roberto Boyle *Arm. illuſtrium comitum de* Burlington & Orrery *fratri germano, philoſophorum principi, hanc ſuam diſquiſitionem anatomicam ſacram voluit* Gualterus Needham, *M. D.* and he owns in the Preface, that this treatiſe was drawn up and publiſhed at the ſolicitation of Mr. *Boyle*.

IN the beginning of the year 1668 he wrote a letter of thanks to Dr. *Thomas Sydenham*, upon receiving from him a preſent of the ſecond edition of his *Methodus curandi Febres*, dedicated to him, as the former had been; to which the doctor returned an anſwer, dated April 2, 1668, in which he confirms his own practice in the ſmall pox[a], to which Mr. *Locke* had been a witneſs, and with regard to which he declares, that he had found no cauſe from his beſt obſervation, to repent of any thing ſaid by him in his tract *de Variolis*; though he greatly regretted, that he had not ſaid, that conſidering the practices, that obtained both amongſt learned and ignorant phyſicians, it had been happy for mankind, that either the art of phyſic had never been exerciſed, or the notion of *malignity* never been ſtumbled upon. "As it is palpable, *ſays he*, to all the world, how fatal that diſeaſe proves to many of all "ages, ſo it is moſt clear to me from all the obſervations, that I can poſſibly make, that if "no miſchief be done, either by the phyſician or nurſe, it is the moſt ſlight and ſafe of all "other diſeaſes. If it ſhall be your hap to be ſeized of that diſeaſe, (as probably you never "may) I ſhould recommend to you, upon the word of a friend, the practice mentioned in "the 155th page of my book." He then takes notice of ſome accidents, which are incident to that diſeaſe, which he was never maſter of till the ſummer before; and of his own ſucceſs in general. "I have the happineſs, adds he, of curing my patients; at leaſt of having it ſaid "concerning me, that few miſcarry under me; but cannot brag of my correſpondency with "ſome others of my faculty, who, notwithſtanding my profoundneſs in palmiſtry and che-"miſtry, impeach me of great inſufficiency, as I ſhall likewiſe do my taylor, when he makes "my doublet like a hop-ſack, and not before, let him adhere to what hypotheſis he will. "Though yet in taking fire at my attempts to reduce practice to a greater eaſineſs and plain-"neſs, and in the mean time letting the mountebank at *Charing-Croſs* paſs unrailed at, they "contradict themſelves, and would make the world believe I may prove more conſiderable "than they would have me. But to let theſe men alone to their books, I have again taken "breath, and am purſuing my deſign of *ſpecifics*, which, if but a deluſion, ſo cloſely haunts "me, that I could not but indulge the ſpending of a little money and time at it once more. "I have made a great progreſs in the thing, and have reaſon to hope not to be diſappointed." But it does not appear, that this *Deſign of Specifics* was ever executed by Dr. *Sydenham*; at leaſt, it was never communicated to the world.

THE Royal Society had from its firſt inſtitution alarmed the zeal of the admirers of the old philoſophy, who affected to repreſent the views of many of its Members to be the deſtruction, not only of true learning, but even of religion itſelf. This gave occaſion to Dr. *Sprat*'s *Hiſtory of the Royal Society*, printed in 1667, and to a diſcourſe publiſhed at *London* in 1668, in 8vo, by Mr. *Joſeph Glanvill*, rector of the church of *Bath*, and afterwards chaplain to King *Charles* II. and prebendary of *Worceſter*, under the title of *Plus Ultra: or, the Progreſs and Advancement of Knowledge ſince the days of* Ariſtotle, *in an account of ſome of the moſt remarkable late Improvements of practical uſeful Learning, to encourage philoſophical Endeavours. Occaſioned by a Conference with one of the notional way.* This conference was with Mr. *Robert Croſſe*, vicar of *Great Chew* in *Somerſetſhire*, who maintained, that "*Ariſtotle* had more advantages for knowledge than the *Royal Society*, or "all the preſent age had, or could have, becauſe he did *totam peragrare Aſiam*[b]." Mr. *Glanvill* in his 12th chapter, which treats of *the Royal Society*, ſhews the reaſons of their inſtitution,

[a] Vol. V. p. 639, 640.

[b] *Glanvill*'s *Plus Ultra*, Ch. I.

and

and their deſigns; and returns an anſwer to the queſtion, *What have they done?* In the next chapter he gives *an account of what hath been done by the illuſtrious Mr.* Boyle, *for the promotion of uſeful knowledge*; and obſerves[a], that he alone had even then *done enough to oblige all mankind, and to erect an eternal monument to his memory; ſo that had this great perſon lived in thoſe days, when men godded their benefactors, he could not have miſſed one of the firſt places among their deified mortals*; and that in his writings are to be found *the greateſt ſtrength and the gentleſt ſmoothneſs, the moſt generous knowledge and the ſweeteſt modeſty, the nobleſt diſcoveries and the ſincereſt relations, the greateſt ſelf-denial and the greateſt love of men, the profoundeſt inſight into philoſophy and nature, and the moſt devout, affectionate ſenſe of God and of religion.* However this piece did not reſtrain Mr. *Henry Stubbe* the phyſician from publickly attacking the Royal Society with prodigious warmth and ſeverity, upon ſeveral chimerical pretences; and particularly, that the Members of it intended to bring contempt upon ancient and ſolid learning, eſpecially the Ariſtotelian philoſophy; to undermine the univerſities; to deſtroy the eſtabliſhed religion, and to introduce Popery in its ſtead. Theſe charges he maintains in various tracts of his, *viz. Legends no Hiſtories: or, a Specimen of ſome Animadverſions upon the* Hiſtory of the Royal Society, *London* 1670, in 4to. *The* Plus Ultra *reduced to a* Non Plus: *or a Specimen of ſome Animadverſions upon the* Plus Ultra *of Mr.* Joſeph Glanvill, *London* 1670, in 4to. *Cenſure of certain paſſages contained in* The Hiſtory of the Royal Society, *&c. Oxford* 1670, in 4to. *Campanella revived; or an Inquiry into* The Hiſtory of the Royal Society, *&c. London* 1670, in 4to. and *Reply unto the Letter written to Mr.* Henry Stubbe, *in a defence of* The Hiſtory of the Royal Society, *&c. Oxford* 1671, in 4to. But amidſt theſe outrages againſt that Society, he kept up a correſpondence with Mr. *Boyle*, who ſhewed a ſingular goodneſs of temper, and an uncommon zeal for the public ſervice, in bearing with ſo much pride, paſſion, and indecent treatment from a perſon, whom he had highly obliged, becauſe he thought him, with all his faults, capable of being uſeful to the world. The following letters will give a clear idea of ſo remarkable a man.

" Honoured Sir,

" I AM much obliged unto you for the trouble you gave yourſelf by imparting the contents of my letter to the Members of the Royal Society. I wonder they ſhould imagine this attempt of mine to be an action I was not provoked unto, whereas Mr. *Glanvill*'s book[b] was enough to juſtify any ſeverity of proceedings, it being written by a cabal, and not by him alone. And it is much more ſtrange to me, that they ſhould think, that a man needed particular exaſperations to write againſt that pernicious *Hiſtory*[c]. There is no man deſires to live more in quiet than I do; and to purſue my practice without intermeddling with the affairs of the nation. But if that *Hiſtory* take place, the whole education of this land and all religion is ſubverted; and I profeſs I am not inclined ſilently to expect, till fire, faggots, and exile be the common conſequences of being a proteſtant. I know this great change was no part of the intentions of the King, and ſuch honourable and pious perſons, as firſt aſſociated; but that the hiſtorian exactly complies with *Campanella*, is evident; and it is in vain for you not to meddle with religion amongſt yourſelves, if you thus overthrow it in your writings. Upon this account I ſevered the caſe of your comical wits from that of the other illuſtrious perſonages; nor is there any thing in my book, that reflects on the King or any perſon of learning or quality. I gave the licenſer leave to blot out every thing, that he thought might give juſt offence; and that he did too much, even to the diſturbing of the ſenſe, practiſing the freedom I gave him ſo far, that I am forced to add a Review, thereby to illuſtrate ſome paſſages, which he had, I know not how, nor upon what reaſon, curtailed. It is certain and manifeſt, that the *Hiſtory* muſt be written anew; and I wonder, that any ſhould ſcruple my amendments of it, whereof all that comes out now is but a ſpecimen; for I have much more behind.

" As for Mr. *Glanvill*, it is much, that the Society ſhould now appoint him their ſecretary, (I have not yet ſeen the new model of correſpondence,) ſeeing that he is a man, whom the univerſities hate and ſcorn, and that hath ſo notoriouſly diſobliged the phyſicians, and whoſe credit is now irrecoverably loſt; for if my papers ever come out, it will be in vain for any man to go about to excuſe him from the moſt groſs ignorance, that ever any writer committed; and this action looks as if the Society would own him as a man of worth. Beſides his *Plus Ultra*, his Letter againſt *Ariſtotle* is all miſtakes; and it is evident he never read *Laertius*. My reply to that Letter will be printed at *Oxford*, I hope before the end of the next term; but the publiſhing of that depends upon this; not that they ſcruple at it, being earneſt for it, but that I would keep the buſineſs alive by printing one book after another.

" AT the ſeſſion of parliament you will ſee a *Cenſure* upon certain paſſages in the *Hiſtory*, with a defence of the *Cenſure* approved by as eminent divines as this nation yields; which will convince you, how juſtly I ſay, that the *Hiſtory* ſubverts the proteſtant religion and church of *England*. I never did any thing more unwillingly than to enter upon divinity, though now the thirty nine articles, and homilies, and the proteſtant religion, be the ſubject I defend againſt Popery and Socinianiſm. I underſtood of the King's diſpleaſure at me, and that he ſaid ſome ſevere things; but I was not troubled at it much, being content rather to ſerve him, than to flatter him. I did expect to have been impriſoned, when I firſt

[a] P. 92, 93. [b] *Plus Ultra*. [c] *Sprat*'s Hiſtory of the Royal Society.

" undertook it, and therefore contrived, how I might be freed again, never purposing to " decline the other trouble. But when I bring the case before the Commons, I am sure I " shall here be powerfully abetted, and the Society will have the worse, and whatever they " do before, will add to my plea then. You will see before Twelfth-day, that no inconside- " rable persons will speak favourably of my intentions, and avow the bravery and necessity " of the performance. But I determined not to engage them to discourse their minds before " the book came out.

" BESIDES that book of *Vander Mye*, there is Fonseca *de sanitate tuenda*, which I send " to let you see, what mastick wood will do in the gout. I assure you, it is a wood " I have tried in bodies apt to catarrhs, and it doth not only work powerfully in dry- " ing them, but purges twice or thrice in a day, as I found particularly in Mr. *Garnet*, (that " married the lady *Boswell*,) lately, to his great recovery out of a malignant fever, which ended " with a perfect salivation of three weeks, and after that endangered him of a consumption. " But he was perfectly well and fat again in a few weeks. It is not ill tasted, nor hot, but " after it is swallowed a while, it creates in the throat such a sense, as remains after drinking " pepper-posset.

" If there be any thing, wherein I may serve you, or any other books you need, you " may command them. Had not the Society thus gone about to injure the physicians, I " had gone on with my collection of English receipts, illustrating every experiment out of " the experiments of the greatest physicians. But in this empirical ignorant age such works " are not to be published.

" I suppose you may have seen two pieces of *Tachenius*: there are in them many experi- " ments, that are pretty, discovering the discrepancy of salts, (a thing I have made some in- " quiries into,) and that gold is acid; which agrees with a way I learned to make cheese and " whey with gold colour, which was tried in a consumption by a lady of my acquaintance.

" I HAVE no more to add, but that I am glad the house dismissed that foolish impeach- " ment of my lord *Orrery*. I am,

Warwick, Decemb. 17, 1669.

" Sir, your obliged humble servant,

" HENRY STUBBE.

" I HAD forgot to suggest one thing to the consideration of your Society, that perhaps it " may be manifested at the parliament, that the historian by his book is chargeable with high- " treason; and that there want not such, as think, if your Society own it, they incur a præmu- " nire; so that whatever they may imagine to draw upon me (though I may suffer a while) " will fall worse on them, when the world takes notice of the ground of their actings against " me, and that they do all this, whom I had represented in my preface as unconcerned in " the contest."

MR. *Stubbe* wrote likewise another letter to him from *Warwick* on the 18th of May, 1670, which was as follows.

SIR,

" I NEVER doubted, but that Mr. *Boyle* would never swerve from the rules of honour and " strict virtue, whatever the other virtuosi might do. You are still constant to yourself " and worth; but so are not they. That you might hear several persons of quality incense " the King against me, and that his Majesty let fall some passages, that were severe, it is " not strange to me: I had an account thereof immediately from many hands. I know the " opportunities my enemies have, and under how false representations Princes discern things, " who see but only with others eyes, and glasses obtruded by the virtuosi. I am satisfied in " the justness of my attempt, and the integrity of my designs and sentiments. Had interest " moved me, and either desire of glory, or any other vulgar inducement, moved me, to have " flattered the Royal Society, to have admired the present condition of our nation, to have " betrayed religion, had been my speedy course to effect all my designs. But I needed not any " new courses to be known to the world, or in this country to advance my practice; and " the first thoughts I assumed after the design of opposing the Royal Society, were to desert " the land, to encounter all manner of censures and imprisonment, perhaps death; and " amidst these perplexities I did resolve to proceed, if that they would be so indiscrete, " as not to disclaim those two books. Nor have I yet received any intelligence, that pro- " poseth to me any new and unforeseen danger, and which a man, who is weary to have " out-lived the prosperity, honour, learning of the nation, and who hath no other prospect " than the apparent ruin of his country, would not willingly sink under. Yet I find amidst " these contrasts, that most sober persons commend my design, and that my performances " were necessary, and not mean; and I dare say, that except the misconstructions, which " my Prince puts on my doings, my abettors are more numerous, judicious, and noble than " my enemies. But the conduct of my fate I leave to that power, which irresistibly put " me upon these actings, and permitted me no rest but in pursuing them. Whatever befalls " me, the world will say it was malice in the virtuosi, now that the quarrel is so boldly begun " by me. If you consider the writing of *Glanvill*, you cannot say, that I proceed in too

" exaſperating a way; I did but write by his copy; nor had I equalled him but by out-
" doing him. Beſides it is *reſponſum, non dictum, quia læſit prior.* And though your hiſtorian
" be the more civil in words, yet is his ſenſe parallel to that of *Glanvill*, as I have ſhewed
" in my dedication to both univerſities in my *Animadverſions* on the *Hiſtory*. And what rea-
" ſon the Royal Society had to deal ſo with the phyſicians, if it be true, that they had ſuch
" an eſteem for them, and that ſo many eminent perſons joined with them, I know not, ex-
" cept I accommodate all to a ſubſerviency unto *Campanella*; and then it is eaſy to divine.
" That the biſhop of *Ch.*[a] had made collections in order to the writing of my life, is a
" thing I am aſſured of from one, who gave me an account of the tendency of the papers,
" and of ſome particulars of them; as alſo of a letter of *Glanvill*'s, which was a piece of
" raillery, and paſſed through ſome hands, containing nothing of truth, but like to him.
" They, that put the ſtreſs of their defence on ſuch foundations, are welcome adverſaries;
" yet ſhall I ſay no more to them, than what I wrote a year ago, when I was firſt threatned
" with theſe actions, and which is like to be public in my preface to the *Animadverſions* on
" the *Hiſtory*. The diſingenuity, with which I have been treated, admits of no apology;
" nor can my lord *Brounker* ever acquit himſelf unto the world, for having bragged and told
" the earl of *Ayleſbury*, that he would licenſe it, if I would ſend it unto him, and yet de-
" clined it. It is very falſe printed, nor is the catalogue perfect as to thoſe material. I did
" appoint ſome to be corrected with a pen; but orders at a diſtance are ill obſerved; and I
" durſt not come up to ſee it done, for fear of ſome mechanical philoſophers and their ſtra-
" tagems.

" I DO not yet underſtand by any hands but yours, that there is ſo great a correſpondence
" betwixt the College of Phyſicians and Royal Society. That ſundry of thoſe few, that
" were entred in it, have deſerted and deteſted it, I am ſure; and ſo Dr. *Scarborough* and
" others inform me. Nor do I hear of four intelligent and eminent phyſicians, that heartily
" adhere to the Society; and it is evident, that they betray their faculty, who do it. But
" this point I have largely handled in my fourth part, where Dr. *Merret* is replied unto;
" which piece I do intend not to ſuffer to be publiſhed till Michaelmas. As to thoſe paſſages,
" wherein you ſeem concerned in this piece, I did not think fitting to give you a particular
" account, becauſe you were not directly concerned; for in the aerial column, and that each
" little alteration of the air may be diſcovered by the barometer, I only oppoſe *Glanvill*, who
" ſays it is *concluded* to be ſo; not you, who make no ſuch poſitive concluſion. As to the
" mixtures of liquors with blood, and their operating differently on the blood in a pottinger,
" and when injected into the veins, or aſſumed by the mouth, I did give you notice long
" ago thereof, and that I did not think your argument for Sp. C. C. to be concluſive. But
" there is, I find, a miſtake in what is printed, where it is printed, as if I held the opinion,
" that ſuch mixtures, when injected, and when made in a pottinger, were the ſame; whereas
" I deny it totally, and my page 129 contradicts itſelf and the ſubſequent diſcourſe, if it be
" taken ſo, as I hear you did. I think I gave you an account of ſome *Errata* in my laſt. I
" did not think I needed to mention, that in the *Animadverſions* on the *Hiſtory* I have laughed
" at him, that told you for an arcanum the uſe of ivy-berries; and I have called into ſuſpi-
" cion the redintegration of nitre, it being manifeſt, I think, that you did not uſe the beſt
" nitre in your calcination. Indeed I think I have there given a great inſight into the nature
" of ſalt-petre; yet could have added more, had I deſigned an hiſtory, and not mere *Animad-*
" *verſions*. Beſides when that was written, I did not intend, unleſs forced unto it, to extend
" my papers beyond ten or twelve ſheets. But if any great difference appear betwixt you
" and me, it will be about the ſecond part of your *Uſefulneſs of Experiments for Phyſic*;
" in which book I think we phyſicians do ſuffer much; and that book hath been the
" occaſion of all the inſolencies we have received from *Dowde* to *Glanvill* and *Thompſon*;
" wherein yet your candour would unconcern you, but that others make too much uſe of it
" to our prejudice; and our defence is very facile, as I have briefly ſhewed againſt Dr. *Mer-*
" *ret*. It was a great unhappineſs, that ſeveral perſons of honour like yourſelf ſhould ever
" mix with ſuch inſignificant talkers, as the generality are; for you could get no credit by
" them, and their arrogance and folly would unavoidably run you all into quarrels, if not
" contempt. And it is apparent, that the Royal Society hath not managed things with that
" diſcretion, which was neceſſary; and being informed of their errors, would rather be
" obſtinate than amend them.

" As to my transferring the glory of ſome inventions from my countrymen to others, I
" am ſure I have injured no man thereby; for to deprive any man of undue praiſes is no
" injury; for if I had ſaid, that *Pecquet* did ſuppoſe the air to be like flocks of wool, I had
" ſaid true; yet I did not, but I ſhall do it e'er long, but my reſpects to you hindered me.
" And I do ſuſpect, that the biſhop of *London*'s chaplains, and ſome of the Society, in the
" diſpunging did join againſt me, or elſe ſome others had been charged for plagiaries, or
" men of no reading, who have eſcaped I know not how. But I do think no man was ever
" uſed as I have been; and it is the common concern of mankind, that ſuch courſes be
" not continued.

" I HAVE no more to add, but that I ſhall willingly allow many of the Society the faci-
" lity of improving paſt inventions; but I will not ſay, contrary to my knowledge, that

[a] *Cheſter*, Dr. *John Wilkins*.

" they did invent them, except they will on the other ſide grant unto me, that they are men
" of no reading, and underſtand no more what hath been printed in *Europe*, than what was
" invented in *China* before our commerce with the *Eaſt-Indies*.

" THIS is all, beſides thoſe reſpects, which I ſhall ever pay unto you upon many ſcores,
" and which are ſuch, that except where the common utility of *England* forceth me to the
" contrary, I ſhall ever be

" Your moſt humble ſervant,

" HEN. STUBBE.

I FIND likewiſe a third letter of his dated the 4th of June following:

SIR,

" I RECEIVED yours, as alſo the two books, and I cannot but begin my anſwer with
" expreſſing my ſorrow to find, that you ſtill adhere to the R. S. Except yourſelf, I do
" not hear of any ſober perſon, but approves of my deſign againſt the Society, and they that
" diſſuaded me from it, thought the attempt neceſſary, not dangerous. I beſeech you, Sir,
" conſider the miſchiefs it hath occaſioned in this once flouriſhing kingdom; and if you
" have any ſenſe, not only of the glory and religion, but even the being of your native
" country, abandon that conſtitution. It is too much, that you contributed to its advance-
" ment and repute; the only reparation you can make for that fatal error, is to deſert it be-
" times. Do not you apprehend, that all the inconveniencies, that have befallen the land,
" all the debauchery of the gentry (which ariſeth from that pious and prudent breeding,
" which was and ought to have been continued) will be charged on your account? Do you
" not hear, how much the ſerious and ſober men do blame you? You are much a ſtranger to
" the diſcourſe and ſentiments of men, if you know not, that your name is frequently queſ-
" tioned, and that the integrity of Mr. *Boyle* is diſputed, as if you in the council of trade,
" and by ſome other engagements, had ſhewed yourſelf leſs a patriot and publick ſpirited than
" was imagined. It will be impoſſible for you to preſerve your eſteem, but by a ſeaſonable
" relinquiſhing of theſe impertinents. I tender you this teſtimony of my ſincere reſpects,
" that I am thus free with you; and whilſt others flatter you, there is an old ſervant of yours
" informs you of the truth. What I believe you could never have apprehended, is come to
" paſs; the body of the nation, and all learned men abet me: the two univerſities (eſpecially
" that of *Cambridge*, which was moſt inclined to novelty) avow my quarrel; and they, that
" favoured experimental philoſophy, judge thoſe virtuoſi unfit to proſecute it. The biſhop
" of *Chicheſter* reads againſt them, and intends to hold his lecture a year or two, and that for
" this reaſon, to overthrow the eſteem of them. The concurrence to hear him is ſuch, as
" the univerſity never ſaw before. The elect of *Bath* is as much as any for me, and againſt
" *Glanvill*. In ſum, all men apprehend it now their common intereſt to oppoſe the R. S. I
" know not what any phyſicians may, as the mode is, tell you to your face; but except it be
" ſuch as Dr. *Sydenham*, and young *Coxe*, I believe not one lives, that doth not condemn
" your experimental philoſophy; and either the college, or Sir *Alexander Fraſer*, and the prin-
" cipal of them intend me a letter of thanks for what I have done, with the liberty to print
" it; and perhaps others will follow the precedent; and how conſiſtent theſe things are with
" the repute of the Society you adhere unto, judge you. . . . The biſhop of *London* hath
" licenſed that againſt *Sprat* once more, and approved the preface and dedication to both uni-
" verſities, wherein the paſſages are more ſevere than any yet publiſhed . . . being reſolved
" to keep the controverſy hot, till the R. S. ſubmit to the terms I propoſe, and then they
" had as good diſſolve. I acquaint you with theſe things, that you may conſult your own
" eaſe, and let theſe comediants ſtand or fall alone; and then whatever reply I ſhall at the
" requeſt of the phyſicians at *London* make to you, ſhall be as amicable as it is poſſible. And
" if it pleaſe God to continue us a nation, perhaps you ſhall ſee a nobler project for the ad-
" vancement of uſeful knowledge in reference to phyſic, than ever your Society was capable
" of, and which ſhall add glory to our faculty. It was indeed the popiſh intereſt to depreſs
" the phyſicians, that ſo there might be nothing of learning in the nation to oppreſs them.
" Civil law is gone, the number of learned divines is ſmall, and your R. S. hath deſtroyed
" the ſucceſſion. But there remains enough to retort the ſhame upon the authors, and cover
" you all with ignominy. I have no more to add, but that I ſhall never quit that reſpect,
" which becomes

" Your moſt humble ſervant,

Ragley, June 4, 1670.

" HEN. STUBBE.

SUCH was the impetuous genius of this learned man, of whom, as I ſhall have no other occaſion to mention him again, I ſhall add here this ſhort account, that he was ſon of a miniſter, and born at *Partney* near *Spilſbye* in *Lincolnſhire* on the 28th of February 1631, and at ten years of age ſent to *Weſtminſter* ſchool under the care of Dr. *Richard Buſby*, where by the intereſt of Sir *Henry Vane*, jun. he became one of the King's ſcholars, and in 1649

was

was elected ſtudent of *Chriſt Church* in *Oxford* [a]. In July 1653 he took the degree of Bachelor of Arts [b], and then went to *Scotland*, where he ſerved in the army till 1655; and in December 1656 took the degree of Maſter of Arts. In the beginning of the year following he was appointed ſecond library-keeper of the *Bodleian* library under Dr. *Tho. Barlow*, which poſt he held till the year 1659, when he was removed from it, as well as from his place of ſtudent of *Chriſt Church*, having the ſame year publiſhed a *Vindication* of his patron Sir *Henry Vane*, *An Eſſay on the good old Cauſe*, and a piece entitled, *Light ſhining out of Darkneſs*, with *an Apology for the Quakers*, in which he reflected upon the clergy and the univerſities. He retired then to *Stratford* upon *Avon* in order to practiſe phyſic there, and after the reſtoration joined himſelf to the church of *England, not only*, ſays he in the dedication to biſhop *Morley* of his tranſlation of *Caſa*'s *Arts of Grandeur and Submiſſion, upon account of its being publicly impoſed, (which in things indifferent is no ſmall conſideration, as I learned from the Scottiſh Tranſactions at* Perth,) *but becauſe it is the leaſt defining, and conſequently the moſt comprehenſive and fitting to be national.* In 1661 he went to *Jamaica*, being honoured with the title of his Majeſty's phyſician for that iſland; but that climate not agreeing with his conſtitution, he returned to *England*, and at laſt ſettled in *Warwick*, where he gained very conſiderable practice, as likewiſe at the *Bath*, which he frequented in the ſummer-ſeaſon; but was unfortunately drowned in a river about two miles from that city in a journey to *Briſtol* on the 12th of July 1676, and was interred in the great church at *Bath*, his old antagoniſt Mr. *Glanvill* preaching his funeral ſermon.

BUT to return to the year 1669, in which Mr. *Boyle* gave the world his *Continuation of new Experiments phyſico-mechanical touching the Spring and Weight of the Air and their Effects. The firſt part. Written by way of Letter to the right honourable the lord* Clifford *and* Dungarvan. *Whereto is annexed a ſhort Diſcourſe of the Atmoſpheres of conſiſtent Bodies; ſhewing, that even hard and ſolid Bodies (and ſome ſuch, as one would ſcarce ſuſpect) are capable of emitting Effluvia, and ſo of having Atmoſpheres:* Oxford, in 4to. *A Diſcourſe of abſolute reſt in Bodies*; added to a ſecond edition of his *Certain phyſiological Eſſays*, London, in 4to. *An Invention to eſtimate the Weight of Water in Water with ordinary Balances and Weights*; printed in the *Philoſophical Tranſactions*, N°. L. p. 1001. a tranſlation of which into Latin is annexed to the Latin edition of his *Hydroſtatic Paradoxes*; and a dilucidation of the experiment in an *Hydroſtatic Letter* printed among his tracts in 1672, in 8vo. He wrote alſo the ſame year *a Letter to Dr.* Peter du Moulin, prefixed to the 4th edition of a book, tranſlated by the doctor from French into Engliſh, and printed at *Oxford* 1669, in 12mo, under the title of, *The Devil of* Maſcon: *or, a true Relation of the chief things, which an unclean Spirit did and ſaid at* Maſcon *in* Burgundy *in the houſe of one Mr.* Francis Perreaud, *miniſter of the reformed church in the ſame town. Publiſhed in French lately by himſelf, and now made Engliſh by one, that hath a particular knowledge of the truth of the ſtory.* It was afterwards indeed reported, that Mr. *Boyle* had diſowned the ſtory of that dæmon, as a clear impoſture; but he declares, that he never did this, in a letter to Mr. *Joſeph Glanvill*, dated at *London* Feb. 10, 1677-8, wherein he has theſe words: "Whatever I may have thought of ſome incidental paſſages in the printed book, "yet as to the main ſtory itſelf, the converſation I had with the author, when the thing was "freſh in men's memories, and the notoriety of divers of the circumſtances, ſurmounted "my indiſpoſition to believe ſuch things; and of late years I remember not, that I have "had occaſion to diſcourſe much of it, much leſs to diſown it, eſpecially after a learned and "intelligent traveller, that ſome years ago paſſed by that town, and afterwards viſited me, "informed me, that he found upon the place itſelf juſt motives to believe the truth of it." Dr. *du Moulin*, the tranſlator of the piece laſt mentioned, was ſon of *Peter du Moulin*, the celebrated French proteſtant divine, and had been tutor to the lord viſcount *Dungarvan*, and Mr. *Richard Boyle* his brother, nephews to Mr. *Boyle*; and after the reſtoration was preferred to be chaplain to the King, and prebendary of *Canterbury*. He had an uncommon genius for Latin poetry; and having collected his performances in that kind, he publiſhed them with a dedication to Mr. *Boyle* at *Cambridge* 1670, in 8vo, under the title of *Petri Molinæi P. F.* ΠΑΤΡΩΑ. *Poematum Libelli tres.* I. *Hymni in Symbolum Apoſtolorum.* II. *Eccleſiæ Gemitus.* III. *Sylva Variorum.* In the dedication the doctor highly commends Mr. *Boyle*'s excellent talents in verſe, and his particular reliſh for that kind of poetry, which is devoted to religion. *Cum vero nulla literaturæ pars extra eruditionis tuæ pomœrium poſſit evagari, patere, quæſo, etiam huic poetico labori liberum aperiri apud te angulum. Cui ſanè poſtulationi ut te facilem fore mihimet ſpondeam, tria ſunt. Unum eſt, quod ſeveriora ſtudia poetico melle delenire tibi non eſt inſolens, & in carmine ita excellis, ut niſi excelſiores in te dotes eminerent, ad id unum natus poſſis exiſtimari. Alterum eſt, quod horum poematum nonnulla jamdudum in manibus habuiſti, approbâſti, & cum iis familiaritatem inire non aſpernatus es. Potiſſimum eſt, quod cum ingenii & eruditionis tuæ ſublimitatem immenſum quantum excedat tua erga Deum pietas, & in capaciſſimâ mentis arce regina ſedeat, non poterunt tibi non placere piæ ad Deum aſpirationes, quas tutemet poetico ſpiritu altiùs atque feliciùs attolli non ſemel apud me profeſſus, expertus apud expertum; adjectis hortamentis, quæ mihi ſunt mandatorum loco, ut iſtam aream ſeriò tererem.* The doctor in a letter to Mr. *Boyle*, dated at *Canterbury* Decem. 28. 1669 [c], takes notice of one circumſtance, which deſerves to be mentioned, as it ſhews, how far the prejudices againſt the Royal Society had poſſeſſed the univerſities at that time; for Dr. *Peter Gunning*, afterwards biſhop of *Ely*, *one of the prime licenſers of the*

[a] Wood, Athen. Oxon. Vol. II. [b] Col. Faſti Oxon. Vol. II. [c] See Vol. V. p. 594.

book, would not ſuffer a copy of heroic verſes, which Dr. *du Moulin* had written in commendation of that Society, to be publiſhed with the reſt of his poems. "It grieves me, (adds "he) to ſee a feud between that noble Society and the univerſities, to which Mr. *Glanvill's* "books have much contributed. Your great credit, prudence, and moderation may ſtop "that growing evil, if any thing in the world can."

In 1670 Mr. *Boyle* publiſhed his *Tracts about the coſmical qualities of things*; *coſmical ſuſpicions*; *the temperature of the ſubterraneal regions*; *the temperature of the ſubmarine regions*; *the bottom of the ſea*; to which is prefixed, *an introduction to the hiſtory of particular qualities:* printed at *Oxford* in 8vo, and tranſlated into Latin. In the tract concerning the *coſmical qualities of things*, he ſhews, 1. That they depend partly upon the influence of external agents, as well as the primary affections of matter; ſo that there are many bodies, which in ſeveral caſes act not, unleſs acted upon, and ſome of them act either ſolely or chiefly, as they are acted on by general and unregarded agents. 2. That there are certain ſubtile bodies in the world, which are ready to inſinuate themſelves into the pores of any body diſpoſed to admit their action, or by ſome other way to effect it; eſpecially if they have the concurrence of other unobſerved cauſes, and the eſtabliſhed laws of the univerſe. 3. That a body by a mechanical change of the texture may acquire or loſe a fitneſs to be wrought upon by unheeded agents, and alſo to diverſify their operations on it, by a variation of its texture. He propoſes next the following *coſmical ſuſpicions*, 1. That beſides thoſe more numerous and uniform ſorts of minute corpuſcles, which are by ſome of the modern philoſophers thought to compoſe the æther, there may poſſibly be ſome other kind of corpuſcles fitted to produce conſiderable effects, when they find bodies to be wrought on by them. 2. That ſeveral perſons have diſcovered peſtilential ſteams in the air, before they acted as ſuch upon other bodies. 3. That conſiderable, though ſlow, changes in the internal parts of the earth may occaſion a variation of the mariner's needle. 4. That the ebbing and flowing of the ſea, and ſuch like phænonema, are occaſioned by ſome *coſmical* law of nature; or that the planetary vortex may be not a little concerned in producing ſuch effects. 5. That all endemical and epidemical diſtempers principally depend upon the influence of thoſe globes, which move about us, and the terreſtrial effluvia of our own globe. 6. That thoſe, which are thought the grand rules, by which things corporeal are tranſacted, and which ſuppoſe the conſtancy of the preſent fabric of the world, and a regular courſe of things, are not altogether ſo uniformly complied with, as we preſume; at laſt, as to the lines, according to which the great mundane bodies move, and the boundaries of their motions. 7. That on the other hand we may perhaps take ſuch things for exorbitances and deviations from the ſettled courſe of nature, as, if long and attentively obſerved, will be periodical phænomena of very long intervals; but becauſe men have not ſufficient ſkill and curioſity to obſerve them, nor a life long enough to be able to take notice of a competent number of them, they readily conclude them to be but accidental extravagancies, which ſpring not from any ſettled and durable cauſes. In the diſcourſes concerning *the temperature of the ſubterraneal and ſubmarine regions*, he obſerves, that there are different regions below the earth; that the firſt region of the earth is very variable both as to bounds and temperature; that the ſecond ſeems to be generally cold in compariſon of the other two; that in ſeveral places, which by reaſon of their diſtance from the ſurface of the earth might be referred to the middle region of it, the temperature of the air is very different at the ſame ſeaſons of different years; that the third region of the earth has been obſerved to be conſtantly and ſenſibly, but not uniformly warm, being in ſome places conſiderably hot; that there are two different regions below the ſurface of the ſea, the one extended from the ſuperficies of the water as far downward, as the manifeſt operation of the ſun-beams or other cauſes penetrates, and the other from thence to the bottom; ſo that the upper region muſt vary as to it's extent, according to the difference of the climate and the heat of the ſun, or the nature of the ſoils about the ſhore; but that the lower region is generally cold: he farther tells us, that the bottom of the ſea is very rough and unequal; that the water gravitates conſiderably upon bodies immerſed in it; and that the bottom of the ſea is not diſturbed with ſtorms, but that the water ſtagnates.

There were publiſhed alſo *the ſame year* in the *Philoſophical Tranſactions* two other pieces of his, viz. *New Pneumatical experiments about reſpiration*; No. LXII. and *A continuation* of the ſame *experiments*; No. LXIII.

AMIDST all theſe labours for the public he had been afflicted with a ſevere paralytic diſtemper; but the regimen, which he made uſe of with ſucceſs for his relief, will appear from his letter to his friend *John Mallet*, Eſq;

"*London*, May 23, 1671.

"SIR,

"I AM much obliged to you for the favour of haſtening to me ſuch welcome news, as "that of my brother *Orrery*'s being already put to ſea with ſo fair a wind, as promiſed "he would get quickly to the other ſide of it. Since monday, when I received the favour "of your letter, there came to my hands a deſire from him relating to your kinſman, "Mr. *Pitt*, which was very needleſs; the relation, that gentleman has to you, and the con- "cern you expreſs for him, being more than ſufficient to make me forward to do him all "the ſervice I am able. But this, I fear, will not be very much; for though, through

" the goodneſs of God, my paralytical diſtemper is much leſſened, yet I am far from being " fully cured of it; and during the ſpace of an eleven months paſt ſince it firſt invaded me, " I have taken ſo many medicines, and found the relief they afforded me ſo very ſlow, that it " is not eaſy for me to tell you what I found moſt good by. The things, which to me ſeem " the fitteſt to be mentioned on this occaſion, are, that cordial medicines, eſpecially ſuch, as " peculiarly befriend the *genus nervoſum*, were very frequently and not unuſefully adminiſtered. " That I uſed during this ſickneſs leſs purging phyſic, and that gentle, than in many years " before; and found cauſe to think ſuch evacuations very weakening, and, when they are " not very neceſſary, dangerous. That the dried fleſh of vipers ſeemed to be one of the " uſefulleſt cordials I took; but then I perſevered in taking it daily for a great while. That " I ſeldom miſſed a day without taking the air, at leaſt once, and that even when I was at " the weakeſt, and was fain to be carried in men's arms from my chair into the coach. That " the beſt thing I found to ſtrengthen my feet and legs, and which I ſtill uſe, was ſack " turned to a brine with ſea-ſalt, and well rubbed upon the parts every morning and night " with a warm hand. That for my hands I uſe ſeveral things, and particularly palm oil, " which comes from *Guinea*, and a liquor ſomewhat like the *ſpiritus lavendulæ compoſ.* of the " diſpenſatory, and alſo fomentations with cephalic flowers and herbs, one or other of which " I yet daily continue. But yet I found nothing ſo available as frequent exerciſe of my " hands and feet, in which I continued as far as my ſtrength would poſſibly allow me, getting " ſometimes others to bend the joints of my arms and hands for me. And though this " courſe makes me every day ſore and weary, yet I continue to undergo it, becauſe I think " I find more benefit by it alone, than by all the outward applications of phyſicians and " chirurgeons. Theſe, Sir, are in brief the chief things, that I have obſerved about my " own diſtemper; but how far they will be applicable to *that of your friend, I do not know* " half ſo well, as that in caſe he uſe them, they will prove very effectual, if any thing can " be added to their virtue by the good wiſhes of,

" SIR,

" Your moſt humble and affectionate ſervant,

" R. B.

The ſame year he publiſhed *Some Conſiderations touching the uſefulneſs of experimental and natural Philoſophy, propoſed in a familiar Diſcourſe to a Friend, by way of invitation to the ſtudy of it. The ſecond tome, containing the latter ſection of the ſecond part:* printed at *Oxford* in 4to. and *Tracts: Of a Diſcovery of the admirable Rarefaction of the Air: New Obſervations about the Duration of the Spring of the Air: New Experiments touching the Condenſation of the Air by mere Cold, and its Compreſſion without mechanical Engines: The admirable differing Extenſion of the ſame Quantity of Air rarified and compreſſed: London*, in 4to; a few copies of which *Tracts* were reprinted in 1739, but with the former date, only the *errata* in the firſt edition were corrected in it. He communicated likewiſe in the *Philoſophical Tranſactions*, No. LXXIV. p. 2216, *An Obſervation of a Spot in the Sun, April* 27, 1660.

His next work was *An Eſſay about the Origin and Virtue of Gems; wherein are propoſed and hiſtorically illuſtrated ſome Conjectures about the Conſiſtence of the Matter of Precious Stones, and the ſubjects, wherein their chiefeſt Virtues reſide:* printed at *London*, 1672, in 8vo, and tranſlated into Latin. In this *Eſſay* he informs us, that gems were once fluid, and have their virtues from mineral matter; which he ſhews from their tranſparency, figuration, internal texture, their colours being probably adventitious, heterogeneous matter having being found in their ſubſtance, and metalline or mineral mixtures mixed with their ſmall parts. He obſerves further, that a greater ſpecific gravity in gems argues their metalline or mineral nature, and that metals or minerals may be extracted from them. He tells us, that mineral productions are exceedingly numerous in the bowels of the earth, and that various menſtrua are likewiſe to be found there; and ſhews the formation of gems from a petrifying juice or ſpirit mixing in a ſufficient proportion with the impregnated waters in the earth, ſo as to coagulate and unite with them. That ſome of their real virtues may be derived from hence, that whilſt they were in a fluid form, the petreſcent ſubſtance was mixed with mineral ſolution, tincture, or other impregnated liquor; and that theſe were afterwards coagulated or united, and hardened into a gem.

The ſame year he publiſhed his *Tracts, containing, New Experiments touching the Relation between Flame and Air; and about Exploſion: An hydroſtatical Diſcourſe, occaſioned by ſome Objections of Dr.* Henry More *againſt ſome Explications of new Experiments made by the Author of theſe Tracts. To which is annexed an hydroſtatical Letter, dilucidating an Experiment about a Way of weighing Water in Water: New Experiments of the poſitive or relative Levity of Bodies under Water: About the differing Preſſure of heavy Solids and Fluids: London*, in 8vo. *Some Obſervations about ſhining Fleſh, both of Veal and of Pullet, and that without any ſenſible putrefaction in thoſe bodies:* printed in the *Philoſ. Tranſact.* No. LXXXIX. p. 5108. and *A new Experiment concerning the Effect of the varying Weight of the Atmoſphere upon ſome Bodies in the Water; and ſuggeſting a conjecture, that the very Alteration of the Air in point of Weight may have conſiderable Operations even upon men's ſickneſs or health: Philoſ. Tranſact.* No. XCI. p. 5156.

THE year 1673 produced to the world his *Eſſays of the ſtrange Subtilty, great Efficacy, determinate Nature of Effluviums. To which are annexed New Experiments to make Fire and Flame ſtable and ponderable; with additional Experiments about arreſting and weighing of igneous Corpuſcles; together with a Diſcovery of the Perviouſneſs of Glaſs to ponderable Parts of Flame:* printed at *London* in 8vo, and tranſlated into Latin: and *A Letter concerning Ambergreaſe, and its being a vegetable production: Philoſ. Tranſact.* No. XCVII. p. 6113.

HE wrote likewiſe, in December that year, the following letter to a gentleman in the *Levant*, whom he deſired to tranſmit to him ſuch obſervations, as he thought proper, concerning thoſe countries, and to whom he now ſent ſeveral copies of Dr. *Edward Pococke*'s Arabic tranſlation of *Grotius*'s book *De Veritate Religionis Chriſtianæ*, as a means of propagating Chriſtianity there.

"SIR, *London*, Decem. 10, 1673.

"I WERE as unjuſt to you, as unkind to myſelf, if I ſhould at all deceive you in the "expectation you had, that your letter would not be thought by me, either to need an "apology, or be an impertinence. That liberty of writing to me, which you out of mo- "deſty are pleaſed to ſtile a privilege, is that, whoſe effects I ſhall always look upon as fa- "vours; and the greater, if you give yourſelf the trouble, and me the ſatisfaction, to let "them convey to me what you call the ſtories and obſervations of the country you are in; "for it cannot but be welcome as well as inſtructive to a perſon, that does as much deſire "as want good obſervations about the *Levant*, to receive accounts of ſuch remote places and "things from ſo ſure a hand as yours.

"I HOPE I ſhall not allow myſelf the vanity of receiving the complements you make me "in reference to *Grotius*, but as effects of your civility and charity; what I have been able "to do, having been but to hand over to others thoſe lamps, which that excellent perſon "framed and lighted. But I ſhall confeſs to you, that I have a great deal of ſatisfaction to "find ground to hope, by what you tell me, that my poor endeavours to promote the "Goſpel in thoſe parts, are not like to prove altogether fruitleſs. And though they were firſt "and chiefly deſigned for the converſion of infidels (to which end I hope you will in due "time attempt to make them ſerviceable) yet I muſt not think them miſemployed, if they "be bleſſed to inform or confirm the poor and ill-inſtructed Chriſtians in thoſe parts, eſpecial- "ly ſince the ſame arguments, that work on them, may, through his bleſſing, for whoſe "truth they militate, enable them in time to work on their Mahometan countrymen. I "have therefore by the merchant, to whom you directed me, ſent you three dozen more of "thoſe Arabic books, bound as the others were, being not ſolicitous to exceed that number "now, both becauſe I had but ſhort warning given me of the departure of the ſhips, and "becauſe of the danger of the ſeas; but I hope hereafter to ſend a further ſupply; and in the "mean time muſt return you my humble thanks, both for your zeal and concern in a work, "that aims at the glory of our common maſter, and for thoſe obliging prayers, the con- "tinuation of which is earneſtly begged of you by,

"SIR,

"Your moſt affectionate friend and very humble ſervant,

"R. B.

"A SMALL treatiſe of mine being lately ventured abroad, I preſume the reliſh you "formerly had for philoſophical ſtudies, may keep that from being altogether unacceptable "to you."

THE ſame year *Anthony le Grand*, an eminent Carteſian Philoſopher, dedicated to him his *Hiſtoria Naturæ variis Experimentis & Ratiociniis elucidata, ſecundum Principia ſtabilita in Inſtitutione Philoſophiæ edita ab eodem Authore*, printed at *London* in 8vo. This gentleman was born at *Doway* in *Flanders*, and entered himſelf in the order of Dominican friars, and was afterwards ſent to preſide over the miſſion in *England*, where he reſided many years, and in Auguſt 1695 was tutor to the eldeſt ſon and heir of Mr. *Farmer* of *Tuſmore* in *Oxfordſhire*[a]. In his dedication he does juſtice to Mr. *Boyle*'s univerſal reputation for extenſive learning and amazing ſagacity in every part of experimental philoſophy; and applies to him what *Averroes* ſaid of *Ariſtotle*, that nature had formed him as an exemplar of the higheſt perfection, to which mankind can attain; and obſerves, that the Royal Society paid the higheſt deference to his judgment: *Adeo diffuſa eſt, per totam Angliam, imo per orbem univerſum, nominis tui gloria, ut vix inter eruditos annumeretur, qui ſapientiam tuam non agnoſcit, & cultu peculiari non amplectitur. Enimverò quis* unquam *te* doctior, *ut quondam de Ariſtotele Romanus orator*, quis acutior, quis in rebus vel inveniendis vel judicandis acrior fuit? *Ita enim in rebus adinveniendis ſolers es, ita in detegendis naturæ arcanis ſagax, ita in promovendâ experimentis philoſophiâ felix, ut non immerito de te, quod in Ariſtotelis laudes aliquando veluti lymphatus eſt*

[a] *Wood. Athen. Oxon.* Vol. II. col. 819. 2d Edit.

Averroes,

Averroes, dici queat, quod regula & exemplar ſis, quod natura invenit ad demonſtrandam ultimam perfectionem humanam. *Hæc omnium doctorum, qui te norunt, ſententiâ, cui ſuffragatur celeberrima Londinenſis Regia Societas, quæ tam præclara artis & induſtriæ ſuæ edidit ſpecimina, dum in omnibus, quæ aggreditur, nihil te inconſulto molitur, te aſſerente, numquam diſſentit, te impugnante, nunquam obluctatur.*

In 1674 Mr. *Boyle* publiſhed his *Tracts, conſiſting of obſervations about the ſaltneſs of the ſea: An Account of a Statical Hygroſcope and its uſes, together with an Appendix about the Force of the Air's Moiſture: A Fragment about the natural and preternatural ſtate of Bodies. To all which is premiſed a ſceptical Dialogue about the poſitive or privative nature of Cold: with ſome Experiments of Mr.* Boyle's *referred to in that diſcourſe:* printed at *London*, in 8vo, and tranſlated into Latin. In the *Obſervations concerning the ſaltneſs of the ſea*, he tells us, that the true cauſe of it is from the ſalt, which is diſſolved in it; which ſalt is ſupplied, not only from rocks and other maſſes of ſalt, which at the beginning were, or in ſome places may yet be found, either at the bottom of the ſea, or at the ſides, where the water can reach them; but alſo from the ſalt, which the rains, rivers, and other waters diſſolve in their paſſage through many parts of the earth, and at length carry along with them into the ſea. He informs us of a method to make ſea-water freſh by diſtillation; and obſerves, that the taſte of ſea-water is not ſuch a ſimple ſaline taſte, as ſpring-water would receive from *ſal-gemmæ*, or ſome other pure terreſtrial ſalt diſſolved in it, but a bitteriſh one; which muſt be derived from ſome peculiar cauſe, which authors commonly overlook; and is occaſioned by the liquid and other bitumen, which is carried by ſprings and other waters into the ſea; and he ſuſpects, that the various motion of the ſea, and its being expoſed to the action of the air and ſun, may contribute to give it a taſte other than ſaline, ſince ſea-ſalt by being barely expoſed for many months to the air, and ſometimes put into a gentle agitation by a digeſtive heat, acquired a very different taſte from the ſimple ſolution of ſea-ſalt in common water. He remarks likewiſe, that there are various degrees of ſaltneſs in different parts of the ſea. In his *Account of a Statical Hygroſcope* he informs us, that it is deſigned to ſhew, 1. The different variations of weather in the ſame month, day, and how. 2. How much one year and ſeaſon is drier or moiſter than another. 3. To diſcover and compare the changes of the temperature of the air made by winds, ſtrong or weak; froſty, ſnowy, or other weather. 4. To compare the temperature of different houſes and different rooms in the ſame houſe. 5. To obſerve in a chamber the effects of the preſence or abſence of a fire. 6. To keep a chamber at the ſame degree, or at an aſſigned degree of drineſs. In the *Appendix about the Force of the Air's Moiſture* he gives us inſtances of that force at all ſeaſons, upon animal ſubſtances, vegetables, metals, and minerals, with a deſcription of a *cord-hygrometer*.

The ſecond work, which he publiſhed the ſame year, was intitled, *The Excellency of Theology compared with Natural Philoſophy, as both are the Objects of Mens Study; diſcourſed of in a Letter to a Friend. To which are annexed, ſome occaſional Thoughts about the Excellency and Grounds of the mechanical Hypotheſis:* printed at *London* in 8vo, and tranſlated into Latin. This diſcourſe was written in 1665, while Mr. *Boyle*, to avoid the great plague, which then raged in *London*, was obliged to retire into the country, and frequently to paſs from place to place, unaccompanied with moſt of his books [a].

NEXT followed his *Tracts: containing*, I. *Suſpicions about ſome hidden Qualities of the Air; with an Appendix touching Celeſtial Magnets, and ſome other Particulars.* II. *Animadverſions upon Mr.* Hobbes's Problemata de Vacuo. III. *A Diſcourſe of the Cauſe of Attraction by Suction.* Printed at *London* 1674, in 8vo, and tranſlated into Latin. In the *Suſpicions about ſome hidden Qualities of the Air*, he mentions ſome unheeded cauſes of the ſalubrity or inſalubrity of the air, which may be compriſed under the following propoſitions: 1. That it is probable, that in ſeveral places the ſalubrity or inſalubrity of the air in general may in a great meaſure depend on ſubterraneous expirations. 2. That in ſeveral places endemical diſtempers chiefly or partly depend on ſubterraneous ſteams. 3. That epidemical diſtempers are in a great meaſure occaſioned by ſubterraneous *effluvia*. 4. That moſt diſeaſes called new ones, chiefly or concurrently, depend on thoſe *effluvia*. He then points out the uſes of his doctrine of ſubterraneous and celeſtial effluvia in the air; and tells us, 1. That we may take occaſion from thence to conſider, whether ſeveral changes of temperature and conſtitution in the air, both as to manifeſt and latent qualities, may not ſometimes be derived from the ſcarcity or plenty, and peculiar nature of one or both of theſe ſorts of *effluvia*. 2. That poſſibly ſome bodies, which we are converſant with, may have a peculiar nature, diſpoſition, and fitneſs to be wrought upon by, or to be aſſociated with ſome of thoſe foreign *effluvia*, emitted by unknown bodies lodged under ground, or which proceed from ſome particular planet. For what we call *ſympathies* and *antipathies* depending really on the peculiar textures and other modifications of the bodies, between which theſe friendſhips and hoſtilities are ſaid to be exerciſed, I ſee not, ſays he, why it is impoſſible, that there ſhould be an affinity between a body of a fit or convenient texture, eſpecially as to the ſhape and ſize of its pores, and the *effluvia* of any other body, whether ſubterraneal or ſidereal. 3. That it may be conſidered, whether among the bodies, which we are acquainted with here below, there are not ſome, which may prove receptacles, if not alſo the attractives of ſidereal and other foreign *effluvia*, which rove up and

[a] See the publiſher's advertiſement to the reader.

down in the air. By attractives are meant ſuch magnetical bodies, as are fitted to detain and join with *effluvia*, when by virtue of the various motions, which belong to the air as a fluid, theſe happen to accoſt them. He mentions likewiſe the great effect of the air in producing colours, and ſome *experiments* to manifeſt ſome *hidden qualities in the air*, and ſome *obſervations about the growth of metals in their ore expoſed to the air.*

HE communicated alſo to the editor of the *Philoſophical Tranſactions*, *An Account of the two ſorts of the* Helmontian *Laudanum, together with the Way of the noble Baron* F. M. Van Helmont, *Son to the famous* Johannes Baptiſta, *of preparing his Laudanum.* No. CVII. p. 147.

IN 1675 he publiſhed at *London*, in 8vo, *Some Conſiderations about the Reconcileableneſs of Reaſon and Religion. By* T. E. *a Layman. To which is annexed by the Publiſher a Diſcourſe of Mr.* Boyle *about the Poſſibility of the Reſurrection.* In the beginning of this treatiſe there is mention made of its being to conſiſt of two parts; one, to ſhew, that a Chriſtian *need not* lay aſide his reaſon; and the other, that he is *not commanded* to do ſo; but the author thought fit to keep that paper, which related to the latter, from accompanying the former, which ſeemed the moſt ſeaſonable, and likelieſt to make impreſſions on that ſort of perſons, whom he chiefly deſigned to perſuade. Several pieces of his were likewiſe printed the ſame year in the *Philoſophical Tranſactions*, viz. *A Conjecture concerning the Bladders of Air, that are found in Fiſhes, communicated by* A. J. *and illuſtrated by an Experiment ſuggeſted by the honourable Mr.* Boyle. No. CXIV. p. 310. *A new Eſſay-Inſtrument invented and deſcribed, together with the Uſes thereof.* Ibid. No. CXV. p. 329. *Ten new Experiments about the weakened Spring, and ſome unobſerved Effects of the Air; where occur not only ſeveral Trials to diſcover, whether the Spring of the Air, as it may divers ways be increaſed, ſo may not by other ways than Cold or Dilatation be weakened; but alſo ſome odd Experiments, to ſhew the Change of Colours producible in ſome ſolutions and precipitations by the Operation of the Air.* Ibid. No. CXX. p. 467. *An experimental Diſcourſe of Quickſilver growing hot with Gold.* Ibid. No. CXXII. p. 515. In this laſt piece he obſerves, that he had many years before made trials, whether ſome of the heterogeneous particles, which he found reducible with mercury into a laſting mercurial flux, might not ſo alter it, as to diſpoſe it to heat with gold. *And that there were ſuch*, ſays he, *through God's bleſſing, my trials afforded me poſitive proof about the year* 1652. For when he was alone, that he might not be impoſed upon by others, he took to one part of his prepared mercury ſometimes half the weight, and ſometimes an equal weight of refined gold reduced to a calx or ſubtle powder. This he put into the palm of his left hand, and putting the mercury upon it, ſtirred it and preſſed it a little with the fingers of his right hand, by which the two ingredients were eaſily mingled, and grew not only ſenſibly but conſiderably hot, and that ſo nimbly, that the incaleſcence ſometimes came to its height in about a minute of an hour by a minute-clock. He found the experiment ſucceed, whether he took altogether, or but half as much gold as mercury; but the effect ſeemed to be much greater, when they were employed in equal weight. He tried alſo the ſame mercury with refined ſilver reduced to very fine powder; but he could not perceive any heat or warmth at all, though he was apt to think, with a ſufficient quantity of leaf-ſilver it might have been ſenſible. He made trial oftner than once in the hands of others, who were not a little ſurpriſed and pleaſed with the event; and particularly having given the ingredients to Mr. *Oldenburg*, he deſired him to make the experiment in and with his own hand, in which it proved ſucceſsful within ſomewhat leſs than a minute of an hour. Mr. *Boyle* however tells us, that he will not hence determine, whether thoſe, that are *mercurii corporum*, and were made, as chemiſts preſume, by extraction only from metals and minerals, will each of them grow hot with gold; "as (ſays he) if I much miſtake not, I found antimonial mercury to "do. Nor will I affirm, that every metalline mercury, though never ſo diſpoſed to in-"caleſcence, or even that of ſilver and gold itſelf, is the ſame with that, which the Chryſopœ-"an writers mean by their *philoſophic mercury*, or is near ſo noble as this. Nay I will not "ſo much as affirm, that every mercury obtained by extraction, even from the perfect me-"tals themſelves, muſt needs be more noble and fit, as alchemiſts ſpeak, for the *philoſophic* "*work*, than that, which common mercury ſkilfully freed from its recrementitious and "heterogeneous parts, and richly impregnated with the ſubtle and active ones of congruous "metals or minerals.—But if there be any truth in what ſome of the moſt approved Spagy-"riſts have delivered about a ſolvent of gold, that ſeems of kin, and perhaps is not much "nobler than one that I had; it ſeems allowable to expect, that even ours ſhould be of more "than ordinary uſe both in phyſic and alchemy." This diſcourſe occaſioned Mr. (afterwards Sir) *Iſaac Newton* to write the following [a] letter to Mr. *Oldenburg* from *Cambridge*, dated April 26, 1676.

"SIR,

"* * * * Yeſterday I reading the two laſt *Philoſophical Tranſactions* had the opportunity "to conſider Mr. *Boyle*'s uncommon experiment about the *incaleſcence of gold and mercury.* "I believe the fingers of many will itch to be at the knowledge of the preparation of ſuch a "mercury; and for that end ſome will not be wanting to move for the publiſhing of it, "by urging the good it may do in the world. But, in my ſimple judgment, the noble

[a] In the poſſeſſion of *William Jones*, Eſq.

" author, ſince he has thought fit to reveal himſelf ſo far, does prudently in being reſerved " in the reſt. Not that I think any great excellence in ſuch a ☿, either for medical or " chemical operations; for it ſeems to me, that the metalline particles, with which that " ☿ is impregnated, may be groſſer than the particles of the ☿, and be diſpoſed to mix " more readily with the ☉ upon ſome other account than their ſubtilty; and then in ſo " mixing, their groſſneſs may enable them to give the parts of the gold the greater ſhock, " and ſo put them into briſker motion than ſmaller particles could do, much after the man- " ner, that the ſaline particles, wherewith corroſive liquors are impregnated, heat many " things, which they are put to diſſolve, whilſt the finer parts of common water ſcarce " heat any thing diſſolved therein, be the diſſolution never ſo quick. And if they do " heat any thing (as quick lime) one may ſuſpect, that heat is produced by ſome ſaline " particles lying hid in the body, which the water ſets on work upon the body, which they " could not act on, whilſt in a dry form. I would compare therefore this impregnated ☿ " to ſome corroſive liquor as aqua fortis; the mercurial part of the one to the watery or " phlegmatic part of the other, and the metallic particles, with which the one is impregnated, " to the ſaline particles, with which the other is impregnated; both which I ſuppoſe may be " of a middle nature between the liquor, which they impregnate, and the bodies they diſ- " ſolve, and ſo enter thoſe bodies more freely, and by their groſſneſs ſhake the diſſolved " particles more ſtrongly, than a ſubtiler agent would do. If this analogy of theſe two " kinds of liquors may be allowed, one may gueſs at the little uſe of the one by the indiſ- " poſition of the other, either to medicine or vegetation. But yet becauſe the way, by " which ☿ may be ſo impregnated, has been thought fit to be concealed by others, that have " known it, and therefore may poſſibly be an inlet to ſomething more noble, not to be com- " municated without immenſe damage to the world, if there ſhould be any verity in the " Hermetic writers; therefore I queſtion not, but that the great wiſdom of the noble author " will ſway him to high ſilence, till he ſhall be reſolved of what conſequence the thing may " be, either by his own experience, or the judgment of ſome other, that thoroughly under- " ſtands what he ſpeaks about; that is, of a true Hermetic philoſopher, whoſe judgment " (if there be any ſuch) would be more to be regarded in this point, than that of all the " world beſide to the contrary, there being other things beſide the *tranſmutation of metals*, " (if thoſe great pretenders brag not) which none but they underſtand. Sir, becauſe the " author ſeems deſirous of the ſenſe of others in this point, I have been ſo free, as to ſhoot " my bolt; but pray keep this letter private to yourſelf.

" Your ſervant,

" ISAAC NEWTON."

IN 1676 Mr. *Boyle* gave the public his *Experiments, Notes, &c. about the mechanical origin or production of divers particular qualities: among which is inſerted a Diſcourſe of the Imperfection of the Chemiſts Doctrine of Qualities; together with ſome Reflections upon the Hypotheſis of Alkali and Acidum:* and likewiſe diſcourſes *of the mechanical origin of Heat and Cold: Experiments and Obſervations about the mechanical production of Taſtes: Of Odours: Advertiſements about the Experiments and Notes relating to chemical Qualities: Experiments and Notes about the mechanical Origin and production of Volatility: — Of Fixedneſs: — Of Corroſiveneſs and Corroſibility: Of the mechanical Cauſes of chemical Precipitation: Experiments and Notes about the mechanical Production of Magnetiſm, and of Electricity.* Printed at *London* in 8vo. In the *Mechanical Origin of Heat and Cold* he ſhews, how a great degree of coldneſs may be produced at any time of the year. That a coldneſs may be produced by the mixture of warm bodies, and heat by the mixture of cold bodies. That ebullition is no argument of heat. That the ſame body, which cools ſome liquors, may heat others. That heat is mechanically producible. That agitation, and various determinations, and ſmalneſs of the moving particles, are requiſite to heat. And that not only weather-glaſſes, but likewiſe our ſenſes may give us miſinformation about cold by ſeveral prediſpoſitions, and the temper of our ſenſories, as we find it colder in the air coming out of a hot bath, than when only out of a warm room. In his *Experiments and Obſervations about the mechanical Production of Taſtes* he defines taſte, as belonging to the object, to be that quality, or whatever elſe it be, which enables a body, by its operation, to produce in us that ſenſation, which we feel, or perceive, when we ſay we taſte; and then ſhews, that this quality depends upon the ſhape, ſize, motion, and other mechanical affections of the ſmall parts of the taſted body, and reſults from the aſſociation of two or more of them, not excluding their congruity or incongruity to the organs of taſting. In his *Experiments and Notes about the mechanical Origin and Production of Volatility*, he informs us, that to make a body volatile, the parts muſt be very ſmall, not too ſolid or heavy, but conveniently ſhaped for motion; and that they looſely adhere, or at leaſt be united in ſuch a manner, as does not much indiſpoſe them to be ſeparated by the fire in the form of fumes or vapours. With regard to *Fixedneſs*, he ſuppoſes the qualifications, that conduce moſt to it, are, 1. The groſſneſs or the bulk of corpuſcles the body conſiſts of. 2. The ponderouſneſs or ſolidity of thoſe corpuſcles. 3. The inaptitude of them for avolation, by reaſon of their branchedneſs, irregular figures, crookedneſs, or other inconvenient ſhape, which entangles the particles among one another, and makes them difficult to be extracted. He explains the

theory of *Corroſiveneſs* by obſerving, 1. That it is requiſite, that a corroſive medium ſhould abound with corpuſcles not too big to get in at the pores of the body to be diſſolved, nor yet ſo minute as to paſs through them, as the rays of light through glaſs; or to be unable by reaſon of their great ſlenderneſs and flexibility to disjoin the parts, which they invade. 2. That theſe corpuſcles be of a ſhape fit to inſinuate themſelves into the pores abovementioned, in order to diſſociate the ſolid parts. 3. That they have a competent degree of ſolidity to disjoin the particles of the body to be diſſolved; which ſolidity of ſolvent particles is ſomewhat diſtinct from their bulk, as may appear by comparing a ſtalk of wheat and a metalline wire of the ſame diameter. 4. That the corpuſcles of the menſtruum be ſuch, as are fit to ſeparate the parts of the invaded body, either by their ſhape, minuteneſs, or fitneſs to have their action befriended by aſſiſting cauſes, ſuch as, firſt, the preſſure of the atmoſphere, which may impel them into the pores of bodies, not filled with a ſubſtance ſo reſiſting as common air; and ſecondly, that the intruding corpuſcles may be fitted to receive in thoſe pores by the tranſcurſion of ſubtile ætherial matter, or by the numerous pulſes of the ſwimming corpuſcles of the menſtruum itſelf, whereby, like ſo many little wedges and levers, they may be inabled to force aſunder the little parts, between which they inſinuate. This theory he confirms by experiments. He then explains that of *Corroſibility*, which property appears to him to conſiſt in three requiſites: 1. That the body to be corroded have pores of ſuch a magnitude and figure, that the corpuſcles of the ſolvent may enter them, and agitate the ſolid parts, that incloſe them. 2. That its conſiſtent corpuſcles be of ſuch a bulk and ſolidity, as does not render them incapable of being disjoined by the action of the inſinuating corpuſcles of the menſtruum. 3. This property conſiſts in ſuch a coheſion of the parts, as is not too ſtrong to be ſuperable by the action of the menſtruum. This theory he likewiſe confirms by experiments. With reſpect to *Precipitation* he obſerves, that by it is meant ſuch an agitation or motion of an heterogeneous liquor, as makes the parts of it ſubſide in the form of a powder or other conſiſtent body; and that it may be mechanically accounted for from the gravity and bulk of the diſſolved body, from weakening the ſolvent, and by preſenting another body to be wrought upon, *&c.* And with regard to *Electricity*, he tells us, that electrical bodies act mechanically; and that electricity is producible by mechanical changes.

HE communicated to the public the ſame year, in the *Philoſophical Tranſactions*, *New Experiments about the ſuperficial Figures of Fluids, eſpecially of Liquors contiguous to other Fluids.* No. CXXXI. p. 775. and *A Continuation of the Experiments publiſhed in the next foregoing Tract about Fluids contiguous to other Fluids.* Ibid. No. CXXXII. p. 799.

HE had been for many years a director of the *Eaſt-India* company, and greatly inſtrumental in procuring the charter of it, an abſtract of which is extant among his papers. But his health now not permitting him to attend the committee of that company, he wrote the following letter to *Robert Thompſon*, Eſq; in order to recommend to them the propagation of the Goſpel in thoſe countries, where their commerce gave them an opportunity.

Pall-Mall, March 5, 1676-7.

" Worthy Sir,

" THE continuance of my diſtemper not permitting me to wait on you, as I gladly " would, in *London*, you will, I doubt not, give me leave to preſent you in this paper " ſome of the things, that I would more fully have acquainted you with by word of mouth. " You may remember, that when my health, and the kindneſs of the *Eaſt-India* company, " allowed me to ſit in your committee, I ventured to make a motion, that ſome courſe " might be thought on of doing ſome conſiderable thing for the propagation of the goſpel " among the natives, in whoſe countries we have flouriſhing factories. And indeed it ſeemed " to me very fit, that we, whoſe endeavours God had of late ſo ſignally proſpered, ſhould " pay him ſome little acknowledgment of his many bleſſings, and that remembring our- " ſelves to be Chriſtians, as well as merchants, we ſhould attempt to bring thoſe countries " ſome ſpiritual good things, whence we ſo frequently brought back temporal ones. And I " was ſomewhat the more concerned to ſucceed in the motion I made, becauſe I wiſhed the " company were enough to deſire, that they in particular ſhould have the honour to ſilence " the reproaches of thoſe, who I wiſh had leſs pretence to upbraid the Proteſtants, and among " them the Engliſh, with the neglect of making proſelytes to the Chriſtian religion; to the " advancement of which I endeavoured to excite you by what hath been done by the Dutch " company in *Batavia*. I muſt do and have done thoſe, that were preſent at my propoſal, " the right to ſay, that they gave me a very favourable hearing, and readily conſented to " take the matter into further conſideration. But as my ſickneſs diſabled me from going ſo " far as the *Eaſt-India* houſe, ſo other accidents have from time to time been able to produce " ſuch delays, that notwithſtanding the interpoſition of my lord *Berkeley*, (who uſes not to " be backward, when good is to be done,) the good intentions of the company have hitherto " proved ineffectual. But I am glad to find, that now the conſideration of that buſineſs is " to be ſeriouſly reſumed among you, my lord *Berkeley* having yeſterday done me the honour " to viſit me, and diſcourſe with me about this affair. And ſince I cannot wait on you my- " ſelf, and have acquainted him with ſome of my thoughts, I ſhall deſire you at your next " meeting to confer with his lordſhip about the ways of promoting ſo good a work. And I

" the

" the rather ſolicit this now, becauſe ſince the beginning of this week I received the honour " of a viſit from the biſhop of *Oxford*, with whom diſcourſing of divers things relating to " religion, his lordſhip ſeemed to wonder, that the *Eaſt-India* company ſhould do nothing " towards the ſpreading of it in the country they trade to, and ſeemed unwilling to ſend " able men thither for miniſters. And though I took this occaſion to right the company by " ſhewing him, that he had been miſinformed, and to relate to him the matter of fact, " which I could do in great part upon my own knowledge; yet his lordſhip having aſſured " me, that in caſe reaſonable encouragement were given, ſober and learned men ſhould be " fitted in the univerſity, to be ſent into *India*, and furniſhed, not only with the Arabic " tongue, but, if it were deſired, with arithmetic and other qualifications fit to recommend " them, and make them appear more conſiderable, and grow more uſeful in thoſe parts; I " cannot but take this riſe to ſolicit you to reſume in good earneſt the thoughts of ſpeedily " doing ſomething worthy of the famous *Eaſt-India* company of *England*. The way I leave to " your wiſdoms, not deſpairing, that if but ſo much be done at firſt, as may be carried with- " out conſiderable oppoſition, the goodneſs of the work will procure a bleſſing on it, that will " make it proſperous; and the ſucceſs will invite perhaps many more than your own company " to be co-operators with the truth, and contributors to the enlarging the Pale of the Chriſtian " church. If you ſhould now aſk me, what is to be done with any ſtock or income, that " may be raiſed for ſuch an uſe? I ſhall willingly at large acquaint you with my poor " thoughts the next time you paſs this way; and in the mean time give me leave to put " you in mind of what is done in the corporation (whereof you are a member) for goſpel- " lizing (as they phraſe it) the natives of *New England*. For the ways we employ to convert " and inſtruct them are chiefly theſe. Firſt, We have cauſed the holy ſcripture and ſome few " choice practical books to be tranſlated into their chiefeſt language. To which you may add " the publiſhing of a ſolid but civilly penned confutation of the authentic books, wherein " the Bramins religion is contained.

" NEXT, we have cauſed ſome of ours to learn their tongue; and having convinced them " of their idolatry and the ſinfulneſs of their courſes, to preach to them, and to catechiſe " them in their own language.

" AND then we breed ſome of their hopeful forward youths to that knowledge of the " Engliſh tongue and European learning, that they may afterwards be able to confute the " idolatrous prieſts, and convert and inſtruct their own countrymen.

" OTHER methods we do on ſome occaſions employ; but to particulariſe and inſiſt on " them would require more than a letter; and this, I fear, is grown too tedious already, and " therefore I ſhall here conclude it with my hearty wiſhes, that, eſpecially at a time, when " the company wants not enemies, they may be directed to do a thing ſo good in itſelf, and " of ſo good a report, as that, which has been recommended to you, I hope, by your own " piety, as well as by the motion of,

" SIR,

" Your moſt affectionate friend, and moſt humble ſervant,

" ROBERT BOYLE.

HIS zeal for the intereſt of the Chriſtian religion appeared the year following in another remarkable inſtance; for he was at the expence of printing five hundred copies of the *four Goſpels*, and *the Acts of the Apoſtles*, in the Malayan tongue, under the direction of Mr. (afterwards Dr.) *Thomas Hyde*, keeper of the Bodleian library. This work was publiſhed at *Oxford* in 1677 in 4to, with this title: *Jang Ampat Evangelia derri tuan Kitu Jeſu Chriſti duan Beorboutan derri jang Apoſtoli Borſacti Berſalin dallam Baſſa Malayo. That is, The four Goſpels of our Lord Jeſus Chriſt, and the Acts of the holy Apoſtles, tranſlated into the Malayan tongue:* with a preface by Dr. *Thomas Marſhal*, rector of *Lincoln* college in *Oxford*, and afterwards dean of *Glouceſter*, and with the following dedication by Mr. *Hyde*, which I ſhall here inſert from the original.

" *To the honourable* Robert Boyle, *Eſq; one of the directors of the* Eaſt-India " *company for trade, and governour of the corporation for the propagation of the* " *Goſpel and the converſion of the American natives in* New England.

" SIR,

" YOUR pious deſign of printing the holy Goſpels, and the Acts of the Apoſtles, in the " Malayan tongue, being by God's aſſiſtance finiſhed, at your coſt and charge, as cor- " rect as all my diligence could poſſibly make it, the work now done returns to you, offering " itſelf to be employed to that good end and purpoſe, for which you intended it, *viz.* for " God's glory, and the good of the ſouls of thoſe poor Indians, to whom the glorious rays " of the Goſpel have not yet ſhone, or at leaſt in a very obſcure manner; that ſo by this " means they, who ſat in darkneſs and the ſhadow of death, may have great light riſen. " And the converſion of ſuch miſerable infidels from their groſs idolatry, and the gaining of

" ſouls to heaven; being a work ſo very acceptable to both God and man; we well hope, " that this your good example will prove an incitement to others of our nation, to procure " and promote ſuch like laudable undertakings. But your charity is not limited only to the " Eaſt-Indians, for the poor ſouls of the Weſt-Indians are alſo bound to bleſs you, you be- " ing the head of that corporation, which is eſtabliſhed by his majeſty at *London* for the re- " ceiving and diſpoſing of the benefactions of well-minded Chriſtians, (to which the ſaid " corporation do uſually add of their own no ſmall mites) to be tranſmitted to the com- " miſſioners of the united colonies in *New England*, and there to be employed for the pro- " pagation of the Goſpel. By the ſole coſt and care of this forementioned corporation it " was, that the whole bible, and ſome other books of piety, were tranſlated into the language " of *New England* by the pains of the reverend Mr. *Eliot*, who made a grammar, now alſo " in print, for that language, and who daily labours in the work of the Goſpel there, he " having an honorary ſtipend continued to him by the abovementioned corporation. Where- " fore if charity is not grown too cold in theſe northerly parts of the world, thoſe things, " which have been already performed, may juſtly be expected to be ſufficient incentives to " kindle and actuate the zeal of many good people, by whoſe pious endeavours, in the pro- " moting of the Goſpel of our Lord Jeſus Chriſt, all the ends of the earth may in time ſee " the ſalvation of God. All, which I have now to add, is, that God in his goodneſs would be " pleaſed to continue to you long life and happineſs; that ſo you may chearfully go on to " finiſh the good works, which you have begun, and which you farther intend; which is the " hearty prayer of,

" SIR,

Sept. 14, 1677, from the publick library in *Oxford*.

" Your very obliged friend,

" and moſt humble ſervant,

" THOMAS HYDE."

THE ſame year there was publiſhed at *Geneva*, in 4to, a collection of ſome of our author's works, which had been tranſlated into Latin, under this title, ROBERTI BOYLE, *nobiliſſimi Angli, & Societatis Regiæ digniſſimi ſocii, opera varia*; of which collection Mr. *Oldenburg*, in the *Philoſophical Tranſactions*, No. CXXX. p. 766, 767, gives the following account: 1. That it was publiſhed without the conſent or knowledge of the author. 2. That the year in the frontiſpiece of it is one and the ſame, as if the ſeveral treatiſes contained in this volume had been publiſhed in one year; and that the enumeration of thoſe treatiſes, made in the catalogue of this Latin edition, is not according to the time, wherein they were firſt printed; for the *firſt* of the books mentioned in that catalogue was publiſhed in Engliſh in 1660, the *fifth* and *ſixth* in 1661, the *ſecond* in 1662, the *ſeventh* in 1664, the *fourth* in 1666, the *third* in 1670, the *eighth* in 1671, the *tenth* in 1672, and the *ninth* in 1673, " ſo prepoſterouſly " are thoſe books ranged in this catalogue and volume; which the reader was to be informed " of, that by comparing the ſeveral true dates of the firſt edition of this author's works " with the books of others ſince printed, the priority of the experiments, and conſiderations " reſpectively contained in them, may be truly ſtated." 3. That there is no mention made in the general title, nor in any advertiſement, that theſe books are all of them tranſlations out of Engliſh, in which tongue the author wrote them all. 4. That the treatiſe of the *Origin of Forms and Qualities*, and that of *ſubordinate Forms*, are both omitted in this volume, though they were printed even in Latin, at *Oxford*, ever ſince the year 1669, as they had been printed in Engliſh in 1667.

IN 1678 Mr. *Boyle's Short Memorial of ſome Obſervations made upon an artificial Subſtance, that ſhines without any preceding Illuſtration*, was publiſhed in Mr. *Hook's Lectiones Cutler.* No. II. p. 57. and his *Hiſtorical Account of a Degradation of Gold made by an Anti-Elixir, a ſtrange chemical Narrative*, was printed at *London* in 4to, and reprinted there in 1739 in 4to. In this piece, *Pyrophilus*, one of the interlocutors of the Dialogue, obſerves, that though he could not affirm, that " he had with his own hands made *projection* (as chemiſts are wont " to call the ſudden tranſmutation made by a ſmall quantity of their admirable elixir) yet I " can affirm, *ſays he*, much of what hath been urged for the poſſibility of ſuch a ſudden " change of a metalline body by a way, which, I preſume, will ſurpriſe you. For to make " it more credible, that other metals are capable of being graduated or exalted into gold, " by way of *projection*, I will relate to you, that *by the like way* gold has been degraded or " imbaſed. If, *continues he*, it can be made appear, that art has produced an *anti-elixir*, or " agent, that is able in a very ſhort time to work a very notable, though deteriorating " change upon a metal, in proportion to which its quantity is very inconſiderable; I ſee " not, why it ſhould be thought impoſſible, that art may alſo make a *true elixir*, or powder, " capable of ſpeedily tranſmuting a great proportion of a baſer metal into ſilver or gold; " eſpecially if it be conſidered, that thoſe, that treat of theſe *arcana*, confeſs, that it is not " every matter, which may be juſtly called the *Philoſophers Stone*, that is able to tranſmute " other metals in vaſt quantities, ſince ſeveral of theſe writers (and even *Lully* himſelf) make " differing orders or degrees of *elixir*, and acknowledge, that a medicine or tincture of the " firſt or loweſt order will not tranſmute above ten times its weight of an imperfect metal."

However the celebrated chemiſt *Otto Tachenius* was of opinion, that notwithſtanding what is related in this narrative, ſalt of tartar is capable of recovering gold thus debaſed to its original purity.

THE regard, which the great *Newton* had for Mr. *Boyle*, will appear from a very curious letter, which the former wrote to him, explaining his ſentiments upon one of the moſt abſtruſe points of philoſophy, with reſpect to the ætherial medium, which in his *Optics* he propoſes as the mechanical cauſe of gravitation. This letter having never before ſeen the light, will be proper to be inſerted here.

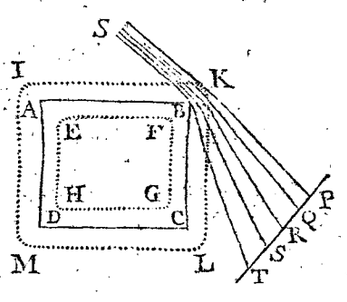
" Honoured Sir,

" I HAVE ſo long deferred to ſend you my thoughts about the phyſical qualities we " ſpake of, that did I not eſteem myſelf obliged by promiſe, I think I ſhould be aſhamed " to ſend them at all. The truth is, my notions about things of this kind are ſo indigeſted, " that I am not well ſatisfied my ſelf in them; and what I am not ſatisfied in, I can ſcarce " eſteem fit to be communicated to others; eſpecially in natural philoſophy, where there is " no end of fancying. But becauſe I am indebted to you, and yeſterday met with a friend, " Mr. *Maulyverer*, who told me he was going to *London*, and intended to give you the trou- " ble of a viſit, I could not forbear to take the opportunity of conveying this to you by " him.

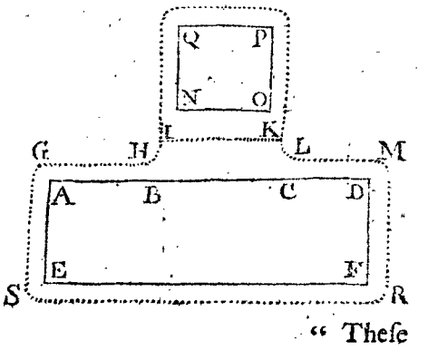
" IT being only an explication of qualities, which you deſire of me, I ſhall ſet down my " apprehenſions in the form of ſuppoſitions, as follows. And firſt, I ſuppoſe, that there is " diffuſed through all places an æthereal ſubſtance, capable of contraction and dilatation, " ſtrongly elaſtic, and, in a word, much like air in all reſpects, but far more ſubtile.

" 2. I SUPPOSE this æther pervades all groſs bodies, but yet ſo as to ſtand rarer in their " pores than in free ſpaces, and ſo much the rarer, as their pores are leſs. And this I ſup- " poſe (with others) to be the cauſe, why light incident on thoſe bodies is refracted towards " the perpendicular; why two well poliſhed metals cohere in a receiver exhauſted of air; " why ☿ ſtands ſometimes up to the top of a glaſs pipe, though much higher than 30 inches; " and one of the main cauſes, why the parts of all bodies cohere; alſo the cauſe of filtration, " and of the riſing of water in ſmall glaſs pipes above the ſurface of the ſtagnating water they " are dipped into: for I ſuſpect the æther may ſtand rarer, not only in the inſenſible pores of " bodies, but even in the very ſenſible cavities of thoſe pipes. And the ſame principle may " cauſe menſtruums to pervade with violence the pores of the bodies they diſſolve, the ſur- " rounding æther, as well as the atmoſphere, preſſing them together.

" 3. I ſuppoſe the rarer æther within bodies, and the denſer without them, not to be ter- " minated in a mathematical ſuperficies, but to grow gradually into one another; the ex- " ternal æther beginning to grow rarer, and the internal to grow denſer, at ſome little " diſtance from the ſuperficies of the body, and running through all intermediate degrees of " denſity in the intermediate ſpaces. And this may be the cauſe, why light, in *Grimaldo*'s " experiment, paſſing by the edge of a knife, or other opake body, is turned aſide, and as " it were refracted, and by that refraction makes ſeveral colours. Let ABCD be a denſe " body, whether opake, or tranſparent, EFGH the outſide " of the uniform æther, which is within it, IKLM the inſide " of the uniform æther, which is without it; and conceive the " æther, which is between EFGH and IKLM, to run " through all intermediate degrees of denſity between that of " the two uniform æthers on either ſide. This being ſuppoſed, " the rays of the ſun SB, SK, which paſs by the edge of this " body between B and K, ought in their paſſage through " the unequally denſe æther there, to receive a ply from " the denſer æther, which is on that ſide towards K, and that " the more, by how much they paſs nearer to the body, and " thereby to be ſcattered through the ſpace PQRST, as by " experience they are found to be. Now the ſpace between the limits EFGH and IKLM " I ſhall call the ſpace of the æther's graduated rarity.



" 4. When two bodies moving towards one another come near together, I ſuppoſe the " æther between them to grow rarer than before, and the ſpaces of its graduated rarity to " extend further from the ſuperficies of the bodies to- " wards one another; and this, by reaſon, that the æther " cannot move and play up and down ſo freely in the " ſtrait paſſage between the bodies, as it could before " they came ſo near together. Thus, if the ſpace of " the æther's graduated rarity reach from the body " ABCDFE only to the diſtance GHLMRS, when " no other body is near it, yet may it reach farther, as " to IK, when another body NOPQ approaches: and " as the other body approaches more and more, I ſuppoſe " the æther between them will grow rarer and rarer.



" Theſe

" THESE ſuppoſitions I have ſo deſcribed, as if I thought the ſpaces of graduated æther " had preciſe limits, as is expreſſed at IKLM in the firſt figure, and GMRS in the " ſecond: for thus I thought I could better expreſs my ſelf. But really I do not think they " have ſuch preciſe limits, but rather decay inſenſibly, and, in ſo decaying, extend to a much " greater diſtance, than can eaſily be believed, or need be ſuppoſed.

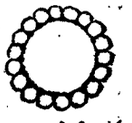
" 5. Now from the fourth ſuppoſition it follows, that when two bodies approaching one " another, come ſo near together, as to make the æther between them begin to rarefy, they " will begin to have a reluctance from being brought nearer together, and an endeavour to " recede from one another: which reluctance and endeavour will encreaſe, as they come " nearer together, becauſe thereby they cauſe the interjacent æther to rarefy more and more. " But at length, when they come ſo near together, that the exceſs of preſſure of the exter- " nal æther, which ſurrounds the bodies, above that of the rarefied æther, which is between " them, is ſo great, as to overcome the reluctance, which the bodies have from being brought " together; then will that exceſs of preſſure drive them with violence together, and make " them adhere ſtrongly to one another, as was ſaid in the ſecond ſuppoſition. For inſtance, " in the ſecond figure, when the bodies ED and NP are ſo near together, that the ſpaces " of the æther's graduated rarity begin to reach to one another, and meet in the line IK; " the æther between them will have ſuffered much rarefaction, which rarefaction requires " much force, that is, much preſſing of the bodies together: and the endeavour, which the " æther between them has to return to its former natural ſtate of condenſation, will cauſe the " bodies to have an endeavour of receding from one another. But on the other hand, to " counterpoiſe this endeavour, there will not yet be any exceſs of denſity of the æther, which " ſurrounds the bodies, above that of the æther, which is between them at the line IK. But " if the bodies come nearer together, ſo as to make the æther in the mid-way-line IK grow " rarer than the ſurrounding æther, there will ariſe from the exceſs of denſity of the ſur- " rounding æther a compreſſure of the bodies towards one another: which when by the " nearer approach of the bodies it becomes ſo great, as to overcome the aforeſaid endeavour " the bodies have to recede from one another, they will then go towards one another, and " adhere together. And, on the contrary, if any power force them aſunder to that diſtance, " where the endeavour to recede begins to overcome the endeavour to accede, they will again " leap from one another. Now hence I conceive it is chiefly, that a fly walks on water " without wetting her feet, and conſequently without touching the water; that two poliſhed " pieces of glaſs are not without preſſure brought to contact, no, not though the one be plain, " the other a little convex; that the particles of duſt cannot by preſſing be made to cohere, " as they would do, if they did but fully touch; that the particles of tinging ſubſtances and " ſalts diſſolved in water do not of their own accord concrete and fall to the bottom, but " diffuſe themſelves all over the liquor, and expand ſtill more, if you add more liquor to " them. Alſo, that the particles of vapours, exhalations, and air, do ſtand at a diſtance from " one another, and endeavour to recede as far from one another, as the preſſure of the in- " cumbent atmoſphere will let them: for I conceive the confuſed maſs of vapours, air, and " exhalations, which we call the atmoſphere, to be nothing elſe but the particles of all ſorts " of bodies, of which the earth conſiſts, ſeparated from one another, and kept at a diſtance, " by the ſaid principle.

" FROM theſe principles the actions of menſtruums upon bodies may be thus explained. " Suppoſe any tinging body, as cochineal, or logwood, be put into water; ſo ſoon as the " water ſinks into its pores and wets on all ſides any particle, which adheres to the body " only by the principle in the ſecond ſuppoſition, it takes off, or at leaſt much diminiſhes " the efficacy of that principle to hold the particle to the body, becauſe it makes the æther " on all ſides the particle to be of a more uniform denſity than before. And then the particle " being ſhaken off, by any little motion, floats in the water, and with many ſuch others makes " a tincture; which tincture will be of ſome lively colour, if the particles be all of the " ſame ſize and denſity; otherwiſe of a dirty one. For the colours of all natural bodies " whatever ſeem to depend on nothing but the various ſizes and denſities of their particles; " as I think you have ſeen deſcribed by me more at large in another paper. If the particles " be very ſmall (as are thoſe of ſalts, vitriols, and gums) they are tranſparent; and as they " are ſuppoſed bigger and bigger, they put on theſe colours in order, black, white, yellow, " red; violet, blue, pale green, yellow, orange, red; purple, blue, green, yellow, orange, " red, *&c.* as is diſcerned by the colours, which appear at the ſeveral thickneſſes of very thin " plates of tranſparent bodies. Whence, to know the cauſes of the changes of colours, " which are often made by the mixtures of ſeveral liquors, it is to be conſidered, how the " particles of any tincture may have their ſize or denſity altered by the infuſion of another " liquor.

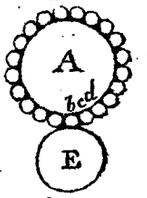
" WHEN any metal is put into common water, the water cannot enter into its pores, to act " on it and diſſolve it. Not that water conſiſts of too groſs parts for this purpoſe, but be- " cauſe it is unſociable to metal. For there is a certain ſecret principle in nature, by which " liquors are ſociable to ſome things, and unſociable to others. Thus water will not mix " with oil, but readily with ſpirit of wine, or with ſalts. It ſinks alſo into wood, which " quickſilver will not; but quickſilver ſinks into metals, which, as I ſaid, water will not. " So aqua fortis diſſolves ☽, not ☉, aqua regis ☉, not ☽, *&c.* But a liquor, which is of itſelf

" unſociable

" unſociable to a body, may, by the mixture of a convenient mediator, be made ſociable. " So molten lead, which alone will not mix with copper, or with regulus of Mars, by the " addition of tin is made to mix with either. And water, by the mediation of ſaline " ſpirits, will mix with metal. Now when any metal is put in water impregnated with " ſuch ſpirits, as into aqua fortis, aqua regis, ſpirit of vitriol, or the like, the particles of " the ſpirits, as they, in floating in the water, ſtrike on the metal, will by their ſociableneſs " enter into its pores, and gather round its outſide particles, and, by advantage of the con- " tinual tremor the particles of the metal are in, hitch themſelves in by degrees between " thoſe particles and the body, and looſen them from it; and the water entering into the " pores together with the ſaline ſpirits, the particles of the metal will be thereby ſtill more " looſed, ſo as, by that motion the ſolution puts them into, to be eaſily ſhaken off, and " made to float in the water: the ſaline particles ſtill encompaſſing the metallic " ones as a coat or ſhell does a kernel, after the manner expreſſed in the annexed " figure. In which figure I have made the particles round, though they may be " cubical, or of any other ſhape.



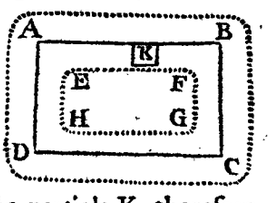
" If into a ſolution of metal thus made be poured a liquor, abounding with particles, " to which the former ſaline particles are more ſociable than to the particles of the metal " (ſuppoſe with particles of ſalt of tartar) then ſo ſoon as they ſtrike on one another in the " liquor, the ſaline particles will adhere to thoſe more firmly than to the metalline ones, " and by degrees be wrought off from thoſe to encloſe theſe. Suppoſe A a metalline particle, " encloſed with ſaline ones of ſpirit of nitre, E a particle of ſalt of tartar, " contiguous to two of the particles of ſpirit of nitre b and c, and ſuppoſe " the particle E is impelled by any motion towards d, ſo as to roll about the " particle c, till it touch the particle d, the particle b adhering more firmly to " E than to A, will be forced off from A. And by the ſame means the particle " E, as it rolls about A, will tear off the reſt of the ſaline particles from A, one " after another, till it has got them all, or almoſt all, about itſelf. And when " the metallic particles are thus diveſted of the nitrous ones, which, as a mediator between " them and the water, held them floating in it; the alcalizate ones crouding for the room the " metallic ones took up before, will preſs theſe towards one another, and make them come " more eaſily together: ſo that by the motion they continually have in the water, they ſhall " be made to ſtrike on one another, and then, by means of the principle in the ſecond ſup- " poſition, they will cohere and grow into cluſters, and fall down by their weight to the bot- " tom, which is called precipitation.



" IN the ſolution of metals, when a particle is looſing from the body, ſo ſoon as it gets " to that diſtance from it, where the principle of receding deſcribed in the fourth and fifth " ſuppoſitions begins to overcome the principle of acceding, deſcribed in the ſecond ſuppoſi- " tion, the receding of the particle will be thereby accelerated; ſo that the particle ſhall as " it were with violence leap from the body, and putting the liquor into a briſk agitation, " beget and promote that heat we often find to be cauſed in ſolutions of metals. And if " any particle happen to leap off thus from the body, before it be ſurrounded with water, " or to leap off with that ſmartneſs, as to get looſe from the water; the water, by the prin- " ciple in the fourth and fifth ſuppoſitions, will be kept off from the particle, and ſtand " round about it, like a ſpherically hollow arch, not being able to come to a full contact " with it any more. And ſeveral of theſe particles afterwards gathering into a cluſter, ſo as " by the ſame principle to ſtand at a diſtance from one another, without any water between " them, will compoſe a bubble. Whence I ſuppoſe it is, that in briſk ſolutions there uſually " happens an ebullition.

" THIS is one way of tranſmuting groſs compact ſubſtances into aereal ones. Another " way is, by heat. For as faſt as the motion of heat can ſhake off the particles of water " from the ſurface of it, thoſe particles, by the ſaid principle, will float up and down in the " air, at a diſtance both from one another, and from the particles of air, and make that ſub- " ſtance we call vapour. Thus I ſuppoſe it is, when the particles of a body are very ſmall " (as I ſuppoſe thoſe of water are) ſo that the action of heat alone may be ſufficient to " ſhake them aſunder. But if the particles be much larger, they then require the greater " force of diſſolving menſtruums, to ſeparate them, unleſs by any means the particles can " be firſt broken into ſmaller ones. For the moſt fixed bodies, even gold itſelf, ſome have " ſaid will become volatile, only by breaking their parts ſmaller. Thus may the volatility " and fixedneſs of bodies depend on the different ſizes of their parts.

" AND on the ſame difference of ſize may depend the more or leſs permanency of aereal " ſubſtances, in their ſtate of rarefaction. To underſtand this, let us " ſuppoſe A B C D to be a large piece of any metal, E F G H the " limit of the interior uniform æther, and K a part of the metal at " the ſuperficies A B. If this part or particle K be ſo little, that it " reaches not to the limit E F, it is plain, that the æther at its centre " muſt be leſs rare, than if the particle were greater; for were it " greater, its centre would be further from the ſuperficies A B, that " is, in a place, where the æther (by ſuppoſition) is rarer. The leſs the particle K therefore, " the denſer the æther at its centre, becauſe its centre comes nearer to the edge A B, where



" the æther is denſer than within the limit EFGH. And if the particle were divided from " the body, and removed to a diſtance from it, where the æther is ſtill denſer, the æther " within it muſt proportionally grow denſer. If you conſider this, you may apprehend, " how by diminiſhing the particle, the rarity of the æther within it will be diminiſhed, till " between the denſity of the æther without, and the denſity of the æther within it, there be " little difference; that is, till the cauſe be almoſt taken away, which ſhould keep this and " other ſuch particles at a diſtance from one another. For that cauſe, explained in the fourth " and fifth ſuppoſitions, was the exceſs of denſity of the external æther above that of the " internal. This may be the reaſon then, why the ſmall particles of vapours eaſily come to- " gether, and are reduced back into water, unleſs the heat, which keeps them in agitation, be " ſo great as to diſſipate them as faſt as they come together: but the groſſer particles of ex- " halations raiſed by fermentation keep their aerial form more obſtinately, becauſe the æther " within them is rarer.

" NOR does the ſize only, but the denſity of the particles alſo, conduce to the permanency " of aerial ſubſtances. For the exceſs of denſity of the æther without ſuch particles above " that of the æther within them is ſtill greater. Which has made me ſometimes think, " that the true permanent air may be of a metallic original; the particles of no ſubſtances " being more denſe than thoſe of metals. This, I think, is alſo favoured by experience, for I " remember I once read in the Philoſophical Tranſactions, how M. *Huygens* at *Paris* found, " that the air made by diſſolving ſalt of tartar would in two or three days time condenſe " and fall down again, but the air made by diſſolving a metal continued without con- " denſing or relenting in the leaſt. If you conſider then, how by the continual fermentations " made in the bowels of the earth there are aerial ſubſtances raiſed out of all kinds of bodies, " all which together make the atmoſphere, and that of all theſe the metallic are the moſt " permanent, you will not, perhaps, think it abſurd, that the moſt permanent part of the " atmoſphere, which is the true air, ſhould be conſtituted of theſe; eſpecially ſince they are " the heavieſt of all other, and ſo muſt ſubſide to the lower parts of the atmoſphere, and " float upon the ſurface of the earth, and buoy up the lighter exhalation and vapours to float " in greateſt plenty above them. Thus, I ſay, it ought to be with the metallic exhalations " raiſed in the bowels of the earth by the action of acid menſtruums, and thus it is with " the true permanent air; for this, as in reaſon it ought to be eſteemed the moſt pon- " derous part of the atmoſphere, becauſe the loweſt, ſo it betrays its ponderoſity, by mak- " ing vapours aſcend readily in it, by ſuſtaining miſts and clouds of ſnow, and by buoying " up groſs and ponderous ſmoke. The air alſo is the moſt groſs unactive part of the at- " moſphere, affording living things no nouriſhment, if deprived of the more tender exha- " lations and ſpirits, that float in it: and what more unactive and remote from nouriſhment " than metallic bodies?

" I SHALL ſet down one conjecture more, which came into my mind now as I was writ- " ing this letter. It is about the cauſe of gravity. For this end I will ſuppoſe æther to " conſiſt of parts differing from one another in ſubtilty by indefinite degrees: that in the " pores of bodies there is leſs of the groſſer æther, in proportion to the finer, than in open " ſpaces; and conſequently, that in the great body of the earth there is much leſs of the " groſſer æther, in proportion to the finer, than in the regions of the air: and that yet the " groſſer æther in the air affects the upper regions of the earth, and the finer æther in the " earth the lower regions of the air, in ſuch a manner, that from the top of the air to the " ſurface of the earth, and again from the ſurface of the earth to the centre thereof, the " æther is inſenſibly finer and finer. Imagine now any body ſuſpended in the air, or lying " on the earth: and the æther being by the hypotheſis groſſer in the pores, which are in the " upper parts of the body, than in thoſe which are in its lower parts, and that groſſer æther " being leſs apt to be lodged in thoſe pores, than the finer æther below, it will endeavour to " get out and give way to the finer æther below, which cannot be without the bodies " deſcending to make room above for it to go out into.

" FROM this ſuppoſed gradual ſubtilty of the parts of æther ſome things above might " be further illuſtrated, and made more intelligible; but by what has been ſaid, you will " eaſily diſcern, whether in theſe conjectures there be any degree of probability, which is all " I aim at. For my own part, I have ſo little fancy to things of this nature, that, had not " your encouragement moved me to it, I ſhould never, I think, have thus far ſet pen to " paper about them. What is amiſs therefore, I hope, you will the more eaſily pardon in

Cambridge, Feb. 28, 1678-9. " Your moſt humble ſervant,

" and honourer,

" ISAAC NEWTON.

THIS letter of our incomparable *Newton* may perhaps receive ſome illuſtration from another *, which he wrote a few years before to Mr. *Oldenburg*, and was as follows.

* In the poſſeſſion of *William Jones*, Eſq.

"SIR,

"I RECEIVED both yours, and thank you for your care in diſpoſing thoſe things between me and Mr. *Linus*. I ſuppoſe his friends cannot blame you at all for printing his firſt letter, it being written, I believe, for that end, and they never complaining of the printing of that, but of the not printing that, which followed, which I take myſelf to have been *per accidens* the occaſion of, by refuſing to anſwer him. And though I think I may truly ſay, I was very little concerned about it, yet I muſt look upon it as the reſult of your kindneſs to me, that you was unwilling to print it without an anſwer.

"As to the paper of Obſervations, which you move in the name of the Society to have printed, I cannot but return them my hearty thanks for the kind acceptance they meet with there, and know not how to deny any thing, which they deſire ſhould be done. Only I think it will be beſt to ſuſpend the printing of them for a while, becauſe I have ſome thoughts of writing ſuch another ſet of Obſervations for determining the manner of the productions of colours by the priſm, which, if done at all, ought to precede that now in your hands, and will do beſt to be joined with it. But this I cannot do preſently, by reaſon of ſome incumbrances lately put upon me by ſome friends, and ſome other buſineſs of my own, which at preſent almoſt take up my time and thoughts.

"THE additions, that I intended, I think I muſt, after putting you to ſo long expectations, diſappoint you in; for it puzzles me how to connect them with what I ſent you; and if I had thoſe papers, yet I doubt the things I intended will not come in ſo freely as I thought they might have done. I could ſend them deſcribed without dependance on thoſe papers; but I fear I have already troubled your Society and yourſelf too much with my ſcribbling, and ſo ſuppoſe it may do better to defer them till another ſeaſon. I have therefore at preſent only ſent you two or three alterations, though not of ſo great moment, that I need have ſtaid you for them; and they are theſe:

"WHERE I ſay, that *the frame of nature may be nothing but æther condenſed by a fermental principle*, inſtead of theſe words write, that it may be nothing but various contextures of ſome certain ætherial ſpirits or vapours condenſed, as it were, by præcipitation, much after the manner, that vapours are condenſed into water, or exhalations into groſſer ſubſtances, though not ſo eaſily condenſable; and after condenſation wrought into various forms, at firſt by the immediate hand of the Creator, and ever ſince by the power of nature, who, by virtue of the command, *Increaſe and multiply*, became a complete imitator of the copies ſet her by the Protoplaſt. Thus perhaps may all things be originated from æther, *&c.*

A LITTLE after, when I ſay, the ætherial ſpirit may be *condenſed in fermenting or burning bodies, or otherwiſe inſpiſſated in the pores of the earth to a tender matter, which may be, as it were, the* ſuccus nutritius *of the earth, or primary ſubſtance, out of which things generable grow:* inſtead of this you may write, that that ſpirit may be condenſed in fermenting or burning bodies, or otherwiſe coagulated in the pores of the earth and water into ſome kind of humid active matter, for the continual uſes of nature, adhering to the ſides of thoſe pores after the manner, that vapours condenſe on the ſides of a veſſel.

"IN the ſame paragraph there is, I think, a parentheſis, in which I mention volatile ſaltpetre. Pray ſtrike out that parentheſis, leſt it ſhould give offence to ſomebody.

"Alſo where I relate the experiment of little papers made to move variouſly with a glaſs rubbed, I would have all that ſtruck out, which follows about trying the experiment with leaf-gold.

"SIR, I am interrupted by a viſit, and ſo muſt in haſte break off.

Yours

Jan. 25, 1675-6. "IS. NEWTON."

BUT to return to Mr. *Boyle*, in the year 1680, he gave the world the following tracts, *viz.* *The Aerial Noctiluca: or ſome new Phænomena, and a proceſs of a factitious ſelf-ſhining ſubſtance*; London, in 8vo. *A new Lamp*, printed in Mr. *Hooke*'s *Philoſophical Collections*, No. II. p. 33. and *Divers Experiments and Notes about the producibleneſs of chemical Principles*, ſubjoined to the ſecond edition of his *Sceptical Chemiſt*, at *Oxford* 1680, in 8vo.

THE Royal Society, of which he had been ſo long one of the greateſt ornaments, now thought proper at their annual election on St. *Andrew*'s day, November 30, this year, to chooſe him for their preſident. But after a mature conſideration he excuſed himſelf from accepting that poſt, for reaſons, which ſhew his extreme tenderneſs and delicacy in all matters of conſcience, and were repreſented by him in the following letter to Mr. *Hooke*.

Pall-Mall, Dec. 18, 1680.

SIR,

"THOUGH ſince I laſt ſaw you, I met with a lawyer, who has been a member of ſeveral parliaments, and found him of the ſame opinion with my council in reference to the obligation to take the teſt and oaths you and I diſcourſed of; yet not content with

"this,

" this, and hearing, that an acquaintance of mine was come to town, whoſe eminent ſkill in " the law had made him a judge, if he himſelf had not declined to be one, I deſired his ad- " vice, (which becauſe he would not ſend me till he had peruſed the Society's charter, I re- " ceived not till late laſt night,) and by it I found, that he concurred in opinion with the two " lawyers already mentioned, and would not have me venture upon the ſuppoſition of my " being unconcerned in an act of parliament, to whoſe breach ſuch heavy penalties are an- " nexed. His reaſons I have not now time to tell you, but they are of ſuch weight with " me, who have a great (and perhaps peculiar) tenderneſs in point of oaths, that I muſt " humbly beg the Royal Society to proceed to a new election, and do ſo eaſy a thing, as " among ſo many worthy perſons, that compoſe that illuſtrious company, to chooſe a pre- " ſident, that may be better qualified than I for ſo weighty an employment. You will ob- " lige me alſo to aſſure them, that though I cannot now receive the great honour they were " pleaſed to deſign me, yet I have as much ſenſe of it, as if I actually enjoyed all the ad- " vantages belonging to it. And accordingly though I muſt not ſerve them in the honoura- " ble capacity they were pleaſed to think of for me, yet I hope, that, God aſſiſting, I ſhall " not be an uſeleſs Member of that learned Body, but ſhall manifeſt in that capacity both " my zeal for their work, and my ſenſe of their favours. This you will oblige me to re- " preſent in ſuch a way, as may perſuade the Virtuoſi, that you will diſcourſe with, how " concerned I am to retain the favourable opinion of perſons, that have ſo great a ſhare in " his eſteem, who ſhall reckon your good offices on ſo important an occaſion among the " welcomeſt favours you can ever do,

" SIR,

" your moſt affectionate friend and humble ſervant,

" RO. BOYLE.

" Superſcribed,
" *Theſe for my much reſpected friend Mr.*
" Robert Hooke, *profeſſor of mathe-*
" *matics at* Greſham College.

ABOUT this time Dr. *Burnet* being employed in compiling his admirable *Hiſtory of the Reformation*, Mr. *Boyle* contributed very largely to the expence of publiſhing it; which is acknowledged by the doctor in his *Preface* to the *ſecond volume*, in theſe words: " The noble " Mr. *Boyle*, as he employs both his time and wealth for the good of mankind, (for which " he conſiders himſelf as chiefly born, and which he has promoted not only in his own excel- " lent writings, that have made him ſo famous over all the world, but in many other deſigns, " that have been chiefly carried on at his coſt,) ſo hath he renewed his kindneſs to me in " largeſſes ſuitable to ſo great a mind."

IN 1681 Mr. *Boyle* publiſhed his *Diſcourſe of things above Reaſon; inquiring, whether a Philoſopher ſhould admit there are any ſuch? To which are annexed by the Publiſher, for the Affinity of the Subject, ſome Advices about judging of things ſaid to tranſcend Reaſon:* London, in 8vo, as he did the year following his *New Experiments and Obſervations made upon the icy Noctiluca: to which is added, A chemical Paradox grounded upon new Experiments, making it probable, that chemical Principles are tranſmutable; ſo that out of one of them others may be produced:* London, in 8vo. and *A Continuation of new Experiments phyſico-mechanical touching the Spring and Weight of the Air and their Effects. The ſecond part; wherein are contained divers Experiments made both in compreſſed and alſo in factitious Air, about Fire, Animals,* &c. *Together with a Deſcription of the Engines, wherein they were made:* London, in 8vo.

IT was probably in the beginning of the year 1681, that he wrote a letter to Mr. *John Eliot* of *New England*, who was one of the firſt, who preached the goſpel among the Indians of that part of *America*, having learned their language to great perfection, and tranſlated into it the Bible [a] and ſeveral books of piety. Mr. *Boyle*'s letter ſeems to be in anſwer to one from Mr. *Eliot*, dated November 4, 1680 [b]; and as it is a ſtrong evidence of his zeal againſt perſecution on account of religious opinions, it deſerves a place here.

" SIR,

" I AM very glad to find, by the favour of your very kind letter, that God is pleaſed to " continue you ſtill an active and an uſeful inſtrument in the propagation of the Goſpel " of his ſon among the poor Indians, whoſe having been ſo true to Chriſtianity, and ſer- " viceable to the Engliſh intereſt, may well prove matter of rejoicing both to you and us. " That little, which I have contributed to their good, deſerves not ſo advantageous a mention, " as your letter makes of it; and duties of that kind have ſuch recompences apportioned to " them by God, that the performers need not ſeek them from the acknowledgments of men. " I am obliged to you for what I perceive you have done for Mr. *Daniel*, whom I look upon " both as an ingenious man, and a friend to *New England*, as well by his good offices " here, as by the moderation, to which he endeavours to perſuade his friends there, which

[a] It was firſt printed in *Cambridge* in *New England* in 1663, in 4to.

[b] Inſerted in the *Appendix* to this *Life*.

" laſt

" laſt clauſe I the rather employ, becauſe of late I have, to my trouble, heard the govern-
" ment of the Maſſachuſets ſharply cenſured for their great ſeverity to ſome diſſenters, who,
" contrary to order, had convened at a meeting-houſe to worſhip God. This ſevere pro-
" ceeding ſeems to be the more ſtrange, and the leſs defenſible, in thoſe, who having left
" their native country, and croſſed the vaſt ocean to ſettle in a wilderneſs, that they may
" there enjoy the liberty of worſhipping God according to their own conſcience, ſeem to be
" more engaged than other men to allow their brethren a ſhare in what they thought was ſo
" much all good men's due. And, indeed, though perſecution for innocent, though perhaps
" erroneous opinions, taken up for conſcience ſake, were not unſuitable to the equity and
" gentleneſs of the Goſpel; yet many of your friends here think it would be a very impro-
" per courſe to be taken by you at this time, and fear, that if your rigorous proceedings
" againſt diſſenters ſhould be talked of here (as, if you quickly forbear them not, they will
" be) it would open men's mouths againſt your government, and furniſh your enemies with
" objections, that your friends would not be able to anſwer; and beſides may be of very bad
" conſequence to that ſort of men here, who do moſt ſymbolize with you in point of opi-
" nion and worſhip. You will eaſily believe, that I, who am never like to viſit your colony,
" have no private ends of my own in what I have now written; and therefore I hope you
" will take it, as it is meant, for a friendly (and perhaps not unſeaſonable) admonition, the
" deſpiſing of which may probably be more prejudicial to your colony, than many among
" you ſeem to be aware of. Our worthy friend, alderman *Aſhurſt* (though now, thanks be
" to God, in a more hopeful condition) was on wedneſday laſt ſo ill, that the corporation
" could not meet at his houſe; and the preſence of that good man was much miſſed amongſt
" us, and particularly in reference to your deſire of having the old teſtament reprinted in
" the Indian language. In his abſence I read to the company that part of your letter to
" me, which concerns that affair, and the buſineſs was diſcourſed of among us; but in re-
" gard we have had no letters from the commiſſioners about it, and that the court thought they
" might hear further before the new teſtament and pſalms would be printed off; they did not
" think fit to determine any more about that buſineſs, till they ſhould have a particular ac-
" count of the progreſs and expence of the work already begun; by which account they ex-
" pect to be aſſiſted to take further meaſures. This I acquaint you with by order of the com-
" pany, divers of whoſe members on this occaſion manifeſted the kindneſs and eſteem, which
" they had for Mr. *Eliot*. I briefly acquainted them alſo with what you wrote to me about
" the * * * people, whoſe language is almoſt the ſame with that of the Maſſachuſets. If
" any further diſcoveries be made of them, you will oblige me to impart it to him, that in
" that and all your other endeavours to enlarge the kingdom of Chriſt, wiſhes you moſt
" proſperous ſucceſs, and is unfeignedly,

" Sir, your moſt affectionate and humble ſervant.

IN 1683 he wrote *A Letter to the learned Dr.* John Beale, *F. R. S. concerning freſh Water made out of Sea-Water, printed at the deſire of the Patentees*, in a tract intitled, *Salt Water ſweetened; or a true account of the great advantages of this new invention both by ſea and land: together with a full and ſatisfactory anſwer to all apparent difficulties. Alſo the approbation of the College of Phyſicians:* London 1683, in 8vo. This piece was written by *R. Fitz-Gerald*, Eſq; who in his dedication to the King obſerves, that " the experiment " was in a great degree owing to eminent Mr. *Boyle*; and indeed well worthy ſo ingenious " a promoter, being ſo much more the favourite of his happy genius, as it is univerſally " uſeful to mankind."

THE year following produced his *Memoirs for the natural Hiſtory of human Blood, eſpecially the Spirit of that Liquor; with an Appendix:* printed at *London*, in 8vo, and tranſlated into Latin; and his *Experiments and Conſiderations about the Poroſity of Bodies, in two Eſſays:* printed likewiſe at *London*, in 8vo. The firſt eſſay treats of the porouſneſs of *animal bodies*, and the ſecond of that of *ſolid bodies*. A Latin tranſlation of this work was alſo publiſhed there in 8vo, the ſame year, under the title *Tentamen Porologicum.*

HIS writings grew now ſo numerous, that Dr. *Ralph Cudworth*, the excellent author of *the true intellectual Syſtem of the Univerſe*, recommended to him in a letter dated October 16, 1684, the procuring all his works to be tranſlated into Latin, and publiſhed together. " Then, " *adds he*, what you ſhall ſuperadd, will be eaſily collected and added afterwards. And I " pray God continue your life and health, that you may ſtill inrich the world with more. " The writers of hypotheſes in natural philoſophy will be confuting one another a long " time, before the world will ever agree, if ever it do. But your pieces of natural hiſtory " are unconfutable, and will afford the beſt grounds to build hypotheſes upon. You have " much outdone Sir *Francis Bacon* in your natural experiments; and you have not inſinuated " any thing, as he is thought to have done, tending to irreligion, but the contrary."

IN 1685 he gave the world his *Short Memoirs for the natural experimental Hiſtory of mineral Waters, addreſſed by way of Letter to a Friend:* printed at *London*, in 8vo. In this book he gives us heads for the natural hiſtory of thoſe waters, with a great many curious experiments. With regard to the methods of trying them, he gives the following directions: 1. To obſerve the changes of the colours made by tinctures in a good light, in order to diſtinguiſh what

what mineral tinctures they are impregnated with. 2. To vary the ſhades of colours made by mineral waters, either by dropping ſuch waters upon paper, whoſe pores are ſaturated with powder of vitriol, or tinged with a decoction of logwood. Several variations alſo of colours may alſo be made by dropping either medicinal liquors into mineral waters, or an infuſion of galls either before or after. 3. He recommends for ſuch experiments the aſtringent parts of plants, or animals, or eſpecially mineral ſubſtances.'

THE next work, which he publiſhed that year, was, *An Eſſay of the great Effects of even languid and unheeded motion: whereunto is annexed, An experimental Diſcourſe of ſome little obſerved Cauſes of the Inſalubrity and Salubrity of the Air and its Effects: London*, in 8vo, and reprinted there in the ſame form in 1690. In this *eſſay* he proves, by ſeveral inſtances, 1. The great efficacy of celerity in bodies very ſmall, eſpecially when the ſpace, which they move through, is but very ſmall, as in lightning. 2. That the inſenſible motion of ſo ſoft bodies as fluids may have a ſenſible effect upon ſolid bodies, as in ſounds, when they ſhake the windows in an houſe, *&c.* at a conſiderable diſtance. 3. That the number of the inſenſible parts of matter put into motion enable them to perform ſeveral things. 4. That local motion may be propagated through ſeveral mediums, and even ſolid bodies. 5. That the effects of particular modifications of the inviſible motions of fluids on animal bodies to be diſpoſed to be worked upon by them, are very conſiderable. Thus a particular note of a muſical inſtrument hath a peculiar effect upon particular animals. 6. That the effects of fluids upon inanimate bodies, by a particular texture and modification of the agent and the patient, are alſo conſiderable. 7. That ſome bodies are thought to have their parts abſolutely at reſt, when they are only in a forced ſtate, as of tenſion, compreſſion, *&c.* 8. That one principal reaſon, why ſuch motions, as we ſpeak of, are overlooked, is, that we ſcarce ever take notice but of thoſe motions of ſolid bodies, wherein one whole body drives away another, or at leaſt viſibly hits againſt it; whilſt many effects proceed from the inteſtine motions produced by the external agent in and among the parts of the ſame body.

HE publiſhed alſo, the ſame year, *An hiſtorical Account of a ſtrangely ſelf-moving Liquor*; printed in the *Philoſophical Tranſactions*, No. CLXXVI. p. 1188; and a diſcourſe, intitled, *Of the Reconcileableneſs of ſpecific Medicines to the corpuſcular Philoſophy: to which is annexed, A Diſcourſe about the Advantages of the Uſe of ſimple Medicines:* printed at *London* in 8vo, and tranſlated into Latin, in which language it was publiſhed there the year following in 8vo. In this book he obſerves, that there are three ſorts of qualities mentioned in the writings of phyſicians, under the notion of ſpecific virtues; for by ſome of them a medicine is ſaid to have a ſpecific quality, becauſe it is eminently and peculiarly beneficial to a particular part of the body, as the heart, the brain, the eyes, *&c.* Others ſay, that a ſpecific remedy attracts and evacuates ſome determinate humour, as choler, phlegm, *&c.* But the moſt uſual account, upon which a medicine is ſaid to be ſpecific, is, that by ſome hidden property it cures this or that particular diſeaſe, as a pleuriſy, an aſthma, the colic, a dropſy, *&c.* This being the common ſenſe, in which the word is employed, Mr. *Boyle* makes uſe of it in that ſenſe. He then urges ſeveral arguments for the exiſtence of ſpecific remedies; and enquires, whether the notion of them may be accommodated to the mechanical philoſophy; and lays down the ſix following propoſitions: 1. A ſpecific medicine may cure by diſcuſſion, or reſolving the morbific matter, and thereby fitting it for expulſion through the greater outlets of the body and cuticular pores. 2. It may ſubdue the too great proportion of acid or other luxuriant particles in the maſs of blood, and prevent their coagulating or, other pernicious effects. 3. It may prove ſerviceable by precipitating the peccant matter out of the blood or other fluid of the body. 4. It may peculiarly ſtrengthen and cheriſh the heart, and by that means, or otherwiſe, relieve the part affected. 5. It may have its effect, by producing in the maſs of blood a diſpoſition to inable nature, by correcting, expelling, *&c.* to ſurmount the cauſe of the diſeaſe. 6. It may unite its particles with thoſe of the peccant matter, and thereby conſtitute ſome different ſubſtance, to be eaſily thrown off, or ſafely continued in the body. He then encourages the uſe of *ſimple medicines*, from the advantage of foreſeeing their effects, and their being more ſafe and commodious for exhibition, eaſily procurable, and likely to improve the knowledge of the *Materia Medica*. He obſerves likewiſe, that chemical remedies ſhould be ſimple; and enquires, whether ſimple remedies may cure complex diſtempers.

BESIDES theſe philoſophical tracts, he gave the world likewiſe, the ſame year, an excellent theological one, *Of the high Veneration Man's Intellect owes to God, peculiarly for his Wiſdom and Power:* printed at *London*, in 8vo. and tranſlated likewiſe into Latin In the advertiſement prefixed to this tract, we are informed, that "the abrupt beginning of it will not be wondered at, when it is declared, that the whole excurſion is to be looked upon as a fragment of a diſcourſe, from which, for certain reaſons, it has been ſeparated in its preſent form; in which it ought to paſs for a rough draught; the nobleneſs, ſublimity and ſacredneſs of the ſubject not allowing the author to preſume, that the firſt thoughts he committed to paper about it, might be for good and all parted with by him, till he ſhould have heedfully reviſed and corrected them, and left in them as few faults, as the diſproportion of ſo vaſt and ſublime a ſubject to his ſlender abilities would permit."

IN 1685-6 he publiſhed his *Free Enquiry into the vulgarly received Notion of Nature; made in an Eſſay addreſſed to a Friend:* printed at *London*, in 8vo, and tranſlated into Latin, and printed there in 1687 in 12mo. In this diſcourſe he obſerves, that this notion is prejudicial to

religion and philoſophy; and he advances a new notion of it, diſtinguiſhing between the *univerſal* and the *particular* nature of things. With regard to *univerſal nature*, he tells us, that nature is the aggregate of the bodies, which make up the world in its preſent ſtate, conſidered as a principle, by virtue whereof they act and ſuffer, according to the laws of motion, preſcribed by the author of things. And that this makes way for the other ſubordinate notion, ſince the *particular nature* of an individual conſiſts in the *general nature* applied to a diſtinct portion of the univerſe; or ſuppoſing that placed, as it is, in a world framed by God, like ours, it muſt be a convention of the mechanical properties (ſuch as magnitude, figure, order, ſituation, and local motion) of parts convenient and ſufficient to conſtitute, or intitle to its particular ſpecies or denomination the particular body, which they make up; the concourſe of all theſe being conſidered as the principle of motion, reſt, and changes in the body.

IN June the ſame year, Dr. *Burnet*, afterwards biſhop of *Saliſbury*, tranſmitted to him from the *Hague* the manuſcript account of his travels [a], which he had drawn up in the form of letters addreſſed to Mr. *Boyle*; who in his anſwer to the doctor, dated the 14th of that month, obſerves, that he was glad to find, that "all men do not travel, as moſt do, to obſerve buildings, and gardens, and modes, and other amuſements of a ſuperficial and almoſt inſignificant curioſity; for your judicious remarks and reflections, *ſays he*, may not a little improve both a ſtateſman, a critic, and a divine, as well as they will make the writer paſs for all three."

THE next work of our great author, which ſaw the light, was, *The martyrdom of Theodora and Didymus*, drawn up in his youth, and printed at *London*, 1687, in 8vo; and the year following he publiſhed *Receipts ſent to a Friend in America: London*, in 12mo; which edition contains only the firſt five decads of *choice remedies*, and hath a preface before it, which was omitted in the ſecond edition in 1692, containing the ſecond five decads. He publiſhed likewiſe, in 1688, *A Diſquiſition about the final Cauſes of natural things; wherein it is enquired, whether, and (if at all) with what caution a Naturaliſt ſhould admit them. To which are ſubjoined, by way of Appendix, ſome uncommon Obſervations about vitiated Sight: London*, in 8vo. In this *Diſquiſition* he examines, whether theſe final cauſes are knowable by men; and obſerves, that they ſignify, 1. Some grand and general ends of the univerſe, ſuch as exerciſing and diſplaying the Creator's wiſdom, the communication of his goodneſs, and the admiration and thanks due to him from his intelligent creatures. 2. In a more reſtrained ſenſe, the ends deſigned in the number, fabric, ſituation, and motion of great maſſes of matter, which make large parts of the world; ſince it is very probable, that theſe bodies, ſuch as the ſun, moon, fixed ſtars, and the terraqueous globe, were ſo framed and placed, as not only to perſevere in their own preſent ſtate, but alſo to conduce to the univerſal ends of the creation, and the good of the whole, whereof they are conſiderable parts. Upon which accounts theſe ends may be called *coſmical* or *ſyſtematical*, as they regard the ſymmetry of the great ſyſtem of the world. 3. Ends, which more peculiarly concern the parts of animals, and perhaps plants too; or thoſe, to which the peculiar parts of animals are deſtined for the welfare of the whole creature, conſidered as an intire and diſtinct ſyſtem of organized parts, deſigned to preſerve himſelf, and propagate his ſpecies, upon that ſtage, on which his ſtructure and circumſtances determine him to act his part; which ends Mr. *Boyle* calls *animal ends*. 4. The ſame expreſſion may ſignify another ſort of ends, which, becauſe they relate particularly to man, may be called *human ends*, and are thoſe aimed at by nature, where ſhe is ſaid to frame animals, vegetables, *&c.* for the uſe of man. And theſe ends may be further diſtinguiſhed into *mental* and *corporeal*, not only as man is an animal, framed, like others, for his own preſervation, and the propagation of his ſpecies; but alſo as he is made to have dominion over other animals and works of nature, and fitted to make them ſubſervient to his purpoſes. This diſtinction being thus ſettled, Mr. *Boyle* declares his diſſent, as well from the vulgar notion of final cauſes, which allows of none but thoſe, which are above called human ones, as from theirs, who wholly reject them all. He obſerves, that chance is an imaginary being; that revelation allows us to ſpeak more poſitively of final cauſes than natural philoſophy; that it is often allowable, from the manifeſt and appoſite uſes of the parts of animal bodies to collect ſome of the particular ends, for which the Creator deſigned them; and in ſome caſes, from the known nature and ſtructure of the parts, to draw probable conjectures about the particular offices of them; that it is rational from the manifeſt fitneſs of ſome things to *coſmical* or *animal ends* to infer, that they were ordained to them by an intelligent agent; that we ought not to be haſty in concluding upon the particular uſe of a thing, or the motive, which induced the author of nature to frame it in a peculiar manner; and that the naturaliſt ſhould not ſuffer the ſearch or diſcovery of final cauſes to make him undervalue or neglect the enquiry after their efficients. In the *Obſervations concerning vitiated Sight* he obſerves, that white objects are moſt viſible to a dim ſight; that both eyes are concerned in real viſion; that the parts of the eye are capable of great dilatation without prejudice; and that colours appear different to diſordered organs.

HE publiſhed likewiſe in May the ſame year 1688, at *London*, in two pages in folio, *An advertiſement about the loſs of many of his writings, addreſſed to* J. W. *to be communicated to thoſe of*

[a] See Vol. V. p. 624, 625.

his

his friends, that are virtuoſi; which may ſerve as a kind of preface to moſt of his mutilated and unfiniſhed writings. And to the ſame purpoſe I find the following papers of his, which ſhew in what manner he had been treated by Plagiaries.

" IN the month of May 1688 I thought myſelf obliged to give notice to the public, " that I had, partly by ſome men's fraud, and partly by miſchance, loſt ſo many of my " eſſays and other tracts, and had ſo many of my remaining papers endamaged by corroſive " liquors, that the curious were not thenceforth to expect from me any thing but imperfect " and mutilitated. And yet ſince that time all my care and circumſpection has not " hindered me from loſing ſix centuries of matters of fact in one parcel, beſides ſo many " other papers of leſſer bulk, that I am reduced to remind the curious of my former adver- " tiſement; not for any pleaſure I take in complaining, or troubling others with my miſ- " fortunes, but to render a reaſon of the courſe I am by theſe miſadventures driven to, " though otherwiſe I ſhould not think it eligible. This is to ſecure the remaining part of " my writings, eſpecially thoſe, that contain moſt matters of fact, by ſending them maimed " and unfiniſhed, as they come to hand, to the preſs."

" BEING wont, when I firſt turned a writer, to ſet down, as well as others uſe to do, my " thoughts and obſervations on papers bound up into books, I was quite diſcouraged from " that practice, by the loſſes I made at ſeveral times of manuſcripts, which I ſtrongly " ſuſpected to have been ſurreptitiouſly conveyed away by ſome, that though they expected " to find valuabler things, than I ſuppoſed they met with, would not probably have ſtollen " away thoſe papers, if their bulk had not been a main temptation to the theft.

" WHEREFORE I afterwards reſolved to write in ſingle ſheets, and other looſe papers, " that the ignorance of the coherence might keep men from thinking them worth ſtealing. " And though I could not, by ſo doing, prevent the loſing ſometimes a paper or two by " chance, or other men's fraud, yet I thought ſuch inconveniencies (which I could ſome- " times eaſily repair out of my memory) much inferior to thoſe of loſing an entire diſcourſe, " or a whole diſcourſe at a time. Now that it may ſeem the leſs ſtrange, that the particu- " lars in the following manuſcript appear to be huddled together, without any either method " or connection, I am to advertiſe, that when I had ſettled the number and titles of the " ſubjects to be treated of in theſe papers, I found myſelf both invaded with a ſickneſs " threatning enough, and likely to be hindred by other diſtracting avocations, from ſetting " down the particulars belonging to the enſuing treatiſe, in ſuch an uninterrupted ſeries, as " I had propoſed to myſelf; which made me reſolve, rather than venture the loſs of my ob- " ſervations, to ſet down under each title or ſection thoſe, that did more particularly belong " unto it, without any other order than that, wherein I lighted on them, contenting myſelf " to leave competent blanks or intervals between the diſtinct obſervations, notions, *&c.* " which courſe I pitch upon, partly, that, if God ſhould be pleaſed to ſpare me life and " leiſure, I might be able to fill them up in the requiſite connexions, tranſitions, *&c.* partly " that I might preſerve the materials, ſome of which do not perhaps deſerve to periſh, but " gave me ſome hopes, that though I myſelf ſhould not complete with them the fabric " I chiefly deſign them for, yet perhaps a ſkilful builder may think fit to perform it; and " that however they may at leaſt prove uſeful for other purpoſes.

" THAT the author may not be diſcouraged from continuing to impart clearly and freely " his experiments and notions to the commonwealth of letters, I think it neceſſary to adver- " tiſe equitable readers, that he has been the worſe dealt with by ſeveral writers, upon the " very account of that candor and faithfulneſs he has exerciſed in delivering matters of fact. " For whereas when experiments and obſervations are related by men, whoſe faithfulneſs is " dubious, the more cautious ſort of plagiaries think themſelves obliged to mention the names " of their authors, leſt an experiment not proving true, its falſity ſhould be (as it juſtly may " be) imputed to them, they think they may ſo ſafely rely on the truth of what our au- " thor relates, that their reputation runs no venture in making any experiment, that he " delivers, paſs for their own.

" THIS hath emboldened ſeveral writers, both formerly and of late, to uſurp from him " a great many things, whereof they were not the authors; ſometimes tranſcribing this or " that particular out of his book into theirs, and ſometimes transferring whole ſets of ex- " periments, if not reaſonings too, perhaps ſomewhat abridged or otherwiſe diſguiſed. " And this hath been done by ſome of them, without ſo much as naming the true author, " and ſometimes naming him indeed as it were incidentally, and peradventure reflectingly, " for ſome inconſiderable part of what they took from him. Of theſe ſeveral ſorts of " plagiaries it would not be difficult to give particular inſtances: it will be done, if it be " thought fit and deſired.

" IT is not unknown to a great part of the curious, that our author hath given eminent " proofs of his readineſs to acknowledge thoſe, whoſe writings he tranſcribes into his, inſo- " much, that ſome new experiments, that were never in the preſs, till he ſent them thither, " and ſo might eaſily have been adopted by him, were declared by him not to be his, though " he yet knew not whoſe they were. It will therefore become ingenuous readers, who would " not diſcourage his candor and communicativeneſs, to think, when they meet with the ſame

" experiment in his writings and in another's, that a perſon, that has been ſo converſant " with nature, and uſes a comprehenſive method in examining the ſubjects he ſolemnly treats " of, may be at leaſt as likely, as moſt others have been, the author of what he delivers as " upon his own knowledge. And particularly it is deſired and hoped, that the equitable " reader will ſo far concern himſelf in the reputation of a perſon, who hazarded it only to " ſerve the public, that he will take notice of the time, when our author's books came " abroad, and that wherein the firſt edition of the books, containing the ſame or the like " things with his, was publiſhed, it having been the ſubtile practice of ſeveral plagiaries, as " well as *Claudius Berigardus*, to aſſign to the ſecond or other ſubſequent editions of their " books the ſame date with the firſt impreſſion, and ſtealing into theſe after-editions many " paſſages, both of other authors and divers other experimental writers, and particularly " divers members of the Royal Society, as if they were as ancient as the firſt edition of " their books, wherein a due collation will diſcover them not to be extant.

" THIS will, it is hoped, appear but a reaſonable requeſt, ſince the thing deſired is ne- " ceſſary to keep a man, that has long faithfully ſerved the commonwealth of learning, " from being thought to have taken from others ſuch things, as others have really taken from " him.

" THOUGH many learned and ingenious foreign writers, eſpecially in *Germany* and *Italy*, " have thought fit, when they made uſe of our author's experiments and obſervations, to do " him juſtice, and ſometimes even obligingly; yet divers others have been far from imi- " tating their laudable example. For they have made uſe, not only of an experiment or " two of his here and there, but ſome of them of whole ſets of experiments; and others " have made bold with the hiſtorical part of whole chapters out of his writings, without " taking notice of them, or perhaps ſo much as naming him. This way of proceeding of- " fended many, and particularly the late learned ſecretary of the Royal Society, Mr. *H. O.* " who publicly complained of it in general terms, and ſhewed the prejudice ſuch plagiaries " muſt naturally do to the commonwealth of learning, eſpecially by diſcouraging the induſtry " of thoſe many, that do not undervalue fame, and by encouraging lazineſs in thoſe nu- " merous pretenders to the new philoſophy, who will never take much pains to promote " experimental knowledge, whilſt they find it far eaſier to uſurp experiments, than to " make them, and think they may ſecurely, by turning plagiaries, paſs for philoſophers. " But though our author's ſtrong inclination to ſerve the publick, and gratify the curious, " has hitherto inabled him to ſurmount the abovementioned diſcouragement; yet thoſe vir- " tuoſi, that are earneſtly deſirous, that the more hiſtorical parts of his remaining writings " may not be expoſed to the accidents, by which ſo many of their companions have been " loſt already, nor the curious kept from things, that may be of uſe or of delight to them, " ſo long as till they may be publiſhed with leſs danger of being uſurped by foreigners; " they have undertaken, for prevention of this danger, both to haſten the tranſlation of the " writings, that will, God granting him life and health, from time to time come abroad; " and whether he be alive or not, to have now and then a liſt drawn up and printed, where- " in the particular experiments, that may have been taken from Mr. *Boyle*'s writings without " owning him for them, will be mentioned, though without any ſevere reflections upon the " writers. This courſe is on this occaſion the rather thought fit, not only that it may take " off a diſcouragement, which might have too much influence upon another than Mr. *B.* " but becauſe in a time, where ſo many falſe, obſcure, or imperfectly delivered experiments, " eſpecially chemical ones, fly abroad, it cannot be indifferent to a wary reader, from what " hand he receives a matter of fact, which one writer may deliver, not only much more " faithfully and perſpicuouſly, but (what in ſome ſorts of nice experiments is very conſider- " able) with greater ſkill than another."

THE decay of Mr. *Boyle*'s health began now to interrupt his communications to the Royal Society, as he obſerves himſelf in a letter to monſieur *Le Clerc*, dated May 30, 1689[a]; and this, added to the ill ſituation of his affairs in *Ireland* upon the revolution, obliged him to re- ſign his poſt of governor of the corporation for propagating the Goſpel in *New England*, &c. which he did by the following letter to that corporation.

" Honoured Gentlemen, Aug. 22, 1689, *Pall-Mall.*

" AS it hath not been without great ſatisfaction, that I have for many years ſerved " ſuch worthy perſons, as I now write to, in promoting ſo excellent a work, as the " propagation of the Goſpel among ſavages, that were utter ſtrangers to it, and worſhiped " the grand enemy of it; ſo it is not without much trouble, that I am now obliged to re- " ſign ſo honourable, and to me grateful an employment. And, indeed, it is none of the " leaſt uneaſy circumſtances of the almoſt continual ſickline ſs, that out of his juſtice, and, " I hope his goodneſs too, God has been pleaſed to exerciſe me with of late years, that my " infirmities have diſabled me to perform the conditions, that the late laws require of thoſe,

[a] Vol. V. p. 246.

" that

" that would continue in that publick ſtation, wherein I counted it a great honour, and ſuch " as deſerved my moſt humble thanks to God for it, that I was preferred to aſſiſt you ſo long in " carrying on your pious and charitable work. But on the other ſide, it may very probably " turn to the advantage of the honourable corporation, who, inſtead of a perſon, that " wants his health, and is for the preſent deprived of all his eſtate in *Ireland*, may make " choice of a governor, vigorous, active, verſed in letting, ſetting, and other oeconomical " affairs, who, eſpecially if he be a ſingle man, may further your pious endeavours, and " contribute to the welfare of your ſociety, not only by his counſel and direction, but with " his purſe. I hope the neceſſity of changing an inſtrument will not diſcourage you from " chearfully proſecuting a deſign, which you may juſtly expect, that God, whoſe glory it " aims at, will bleſs, and graciouſly both proſper and reward. For my part, I have found " among you ſo particular a regard, and ſo much kindneſs to me, during the long continu- " ance of my relation to you, that gratitude obliges me, as well for your own ſake, as for " that of the work you are engaged in, to wiſh and pray, that you may be directed in your " choice, and your next governor may be as faithful and affectionate as your laſt, but much " more capable and proſperous. And though I muſt ceaſe to ſerve you in my former ſtation, " yet you will not find me more backward than formerly to ſerve you faithfully in my re- " duced capacity; and I hope you will do me the right to believe, that to ſee the great and " good work, you are purſuing, proſper in your charitable hands, though I can have the " honour to contribute but my good wiſhes to it, will heartily rejoice,

" Honoured Gentlemen,

" Your moſt faithful and

" moſt humble ſervant."

IT was probably about this time, that he thought proper to publiſh the following adver- tiſement, in order to decline viſits on certain days, that he might have leiſure to finiſh ſome of his works, then lying by him.

" MR. *Boyle* finds himſelf obliged to intimate to thoſe of his friends and acquaintance, " that are wont to do him the honour and favour of viſiting him, 1. That he has by ſome " unlucky accidents (whereof he has given notice to the public) had many of his writings " corroded here and there, or otherwiſe ſo maimed, that without he himſelf fill up the " *lacunæ* out of his memory or invention, they will not be intelligible. 2. That his age " and ſicklineſs have for a good while admoniſhed him to put his ſcattered, and partly de- " faced, writings into ſome kind of order, that they may not remain quite uſeleſs. And, " 3. that his ſkilful and friendly phyſician *, ſeconded by Mr. *Boyle*'s beſt friends, has " preſſingly adviſed him againſt ſpeaking daily with ſo many perſons, as are wont to viſit " him, repreſenting it, as that, which cannot but much waſte his ſpirits, and by obliging " him to ſit a great deal too much for a perſon ſubject to the ſtone of the kidneys, and on " ſeveral other accounts, impair his health, and diſable him for holding out long. And he " is alſo obliged further to intimate, that by theſe and other inducements he does at length, " though unwillingly, find himſelf reduced to deny himſelf part of the ſatisfaction fre- " quently brought him by the converſation of his friends and other ingenious perſons, and to " deſire to be excuſed from receiving viſits (unleſs upon occaſions very extraordinary) two " days in the week, namely on the forenoon of tueſdays and fridays (both foreign poſt " days) and on wedneſdays and ſaturdays in the afternoon, that he may have ſome time, " both to recruit his ſpirits, to range his papers, and fill up the *lacunæ* of them, and to " take ſome care of his affairs in *Ireland*, which are very much diſordered, and have their " face often changed by the public calamities there."

HE ordered likewiſe a board to be placed over his door, with an inſcription ſignifying, when he did and did not receive viſits.

AMONG the works, which he finiſhed during theſe intervals of retirement, was probably a collection of elaborate proceſſes in chemiſtry, which he ſent to a friend, with the following letter.

" SIR,

" I CONFESS you are not the only perſon among my friends, to whom it hath ſeemed " ſomewhat ſtrange, that I, who have ſpent many of my thoughts, ſome of my money, " and, what I value far more, of my time too, upon chemiſtry, as well as divers other " parts of learning, have not been taken notice of to have found any *particulars*, as chemiſts " ſpeak, or other lucriferous experiments upon metals and minerals, nor have pretended to " be poſſeſſor of thoſe difficult and compounded experiments, that are magnified by che- " miſts as excellent *Hermetic Arcana*.

" BUT, Sir, ſince I find you in the liſt of thoſe, that have made the newly-mentioned " reflection, I am content to give you ſuch a ſummary account of my comportment, as

* Sir *Edmund King*.

" may at leaſt leſſen your wonder at it. I muſt inform you then, that when, among " other ſtudies, I applied myſelf to the cultivating of natural philoſophy, I ſoon perceived, " that ſome inſight into chemical operations was, though not abſolutely neceſſary, yet high- " ly conducive to the true knowledge of nature, and eſpecially to the indagation of ſeveral " of her moſt abſtruſe myſteries. On this ſcore I was induced to make a nearer inſpection " into chemiſtry than virtuoſi are wont to think it worth while to do; and I did not re- " pent me of my labour. But as I cultivated chemiſtry, not ſo much for itſelf, as for the " ſake of natural philoſophy, and in order to it, ſo moſt of the experiments I deviſed and " purſued, were generally ſuch, as tended not to multiply proceſſes, or gain the reputation " of having ſtore of difficult and elaborate ones; but to ſerve for foundations, and other " uſeful materials for an experimental hiſtory of nature, on which a ſolid theory may in " proceſs of time be ſuperſtructed. For this purpoſe I judged, that plain and eaſy experi- " ments, and as ſimple, or as little compounded as may be, would, *cæteris paribus*, be the " fitteſt, as being the moſt eaſy to be tried (and, if need be, repeated) and to be judged of, " both in relation to their cauſes, and to their effects. And for theſe reaſons, though I had " by me a not inconſiderable number of more compounded and elaborate proceſſes, ſome " of which I had made, and others I received as great ſecrets from noted artiſts; I purpoſely " forbore to mention any number of them in my writings about phyſics, being deſirous ra- " ther to increaſe knowledge, than make any oſtentation of any, that I thought would puz- " zle moſt readers more than it would inſtruct them.

" THIS, Sir, I hope, will appear to you a fair account of your not finding my phyſical " diſcourſes larded with long and intricate proceſſes, ſome of which may, I willingly grant, " produce notable effects, and for that reaſon are valuable, but are leſs fit than far more ſim- " ple ones to diſcover the cauſes of things, which yet is the chief ſcope of a naturaliſt, as " ſuch. And to thoſe, that think it ſtrange, that among my other experiments about " metals and minerals, I have not produced thoſe gainful ones, that chemiſts call *particulars*, " it may, I hope, ſuffice to repreſent, that being a bachelor, and through God's bounty " furniſhed with a competent eſtate for a younger brother, and freed from any ambition to " leave my heirs rich, I had no need to purſue lucriferous experiments, to which I ſo much " preferred luciferous ones, that I had a kind of ambition (which I now perceive to have " been a vanity) of being able to ſay, that I cultivated chemiſtry with a diſintereſted mind, " neither ſeeking nor ſcarce caring for any other advantages by it, than thoſe of the im- " provement of my own knowledge of nature, the gratifying the curious and induſtrious, " and the acquiſt of ſome uſeful helps to make good and uncommon medicines.

" IF I may be allowed to judge of courſes by the ſucceſs, the entertainment, that the pub- " lic has been pleaſed to give my endeavours to ſerve it, will not make me repent of the way " I have made choice of to do it in. But, however, ſince I find myſelf now grown old, I " think it time to comply with my former intentions to leave a kind of Hermetic legacy to " the ſtudious diſciples of that art, and to deliver candidly, in the annexed paper, ſome pro- " ceſſes chemical and medicinal, that are leſs ſimple and plain than thoſe barely luciferous ones " I have been wont to affect, and of a more difficult and elaborate kind, than thoſe I have " hitherto publiſhed, and more of kin to the nobleſt Hermetic ſecrets, or, as *Helmont* " ſtiles them, *arcana majora*. Some of theſe I have made and tried; others I have (though " not without much difficulty) obtained, by exchange or otherwiſe, from thoſe, that affirm " they knew them to be real, and were themſelves competent judges, as being ſome of them " diſciples of true adepts, or otherwiſe admitted to their acquaintance and converſation. " Moſt of theſe proceſſes are clearly enough delivered; and of the reſt there is plainly ſet " down, without deceitful terms, as much, as may ſerve to make what is literally taught to " be of great utility, though the full and complete uſes are not mentioned, partly becauſe, " in ſpite of my philanthropy, I was engaged to ſecrecy, as to ſome of theſe uſes, and partly " becauſe I muſt ingenuouſly confeſs it, I am not yet, or perhaps ever ſhall be acquainted with " them myſelf. The knowledge I have of your great affection for the public good, and your " particular kindneſs for me, invites me, among the many virtuoſi, in whoſe friendſhip I am " happy, to intruſt the following papers in your hands, earneſtly deſiring you to impart them " to the public faithfully, and without envy, *verbatim*, in my own expreſſions, as a monument " of my good affections to mankind, as well in my chemical capacity, as in the others, wherein " I have been ſollicitous to do it ſervice. I am, with ſincere reſpect,

" SIR,

" Your moſt faithful and moſt humble ſervant,

" ROBERT BOYLE."

THIS collection of chemical proceſſes is not now to be found among his manuſcripts; though there are ſtill extant among them a great number relating to chemiſtry; and it appears, that he left orders, that after his death all his papers upon that ſubject ſhould be examined by three phyſicians nominated by him for that purpoſe[a]; being unwilling, that

[a] Letter of Mr. *John Warr* ſenior to his ſon Mr. *John Warr*, executor to Mr. *Boyle*, dated July 16, 1692.

they

they ſhould be loſt to the public. And indeed it is highly reaſonable to ſuppoſe, that many important diſcoveries were contained in them, chemiſtry being his favourite ſtudy, and opening to him perpetually ſuch a new ſcene of wonders, as eaſily perſuaded him of the poſſibility of the tranſmutation of metals into gold. This perſuaſion of his is evident from ſeveral parts of his writings, and was avowed by himſelf to the great Dr. *Halley*, the late royal aſtronomer, who related to me his converſation with him upon that ſubject; and it was probably in conſequence of this opinion, that Mr. *Boyle* procured by his intereſt the following *act* to be paſſed in Auguſt 1689 *for the repeal of a ſtatute made in the fifth year of King* Henry IV. *againſt the multiplying of gold and ſilver* [a].

" WHEREAS by a ſtatute made and enacted in the parliament held in the fifth year of the " reign of King *Henry* the fourth, late King of *England*, it was, amongſt other things, en- " acted in theſe words, or to this effect, namely, *that none from thenceforth ſhould uſe to mul-* " *tiply gold or ſilver, or uſe the craft of multiplication; and if any the ſame do, they ſhould incur* " *the pain of felony*: And whereas ſince the making of the ſaid ſtatute divers perſons have " by their ſtudy, induſtry, and learning, arrived to great ſkill and perfection in the art of " melting and refining of metals, and otherwiſe improving them and their ores (which very " much abound within this realm) and extracting gold and ſilver out of the ſame; but dare " not exerciſe their ſaid ſkill within this realm, for fear of falling under the penalty of the " ſaid ſtatute, but exerciſe the ſaid art in foreign parts, to the great loſs and detriment of " this realm:

" BE it therefore enacted by the king's and queen's moſt excellent majeſties, by and with " the advice and conſent of the lords ſpiritual and temporal, and commons in this preſent " parliament aſſembled, that from henceforth the aforeſaid branch, article, or ſentence, con- " tained in the ſaid act, and every word, matter, and thing, contained in the ſaid branch or " ſentence, ſhall be repealed, annulled, revoked, and for ever made void; any thing in the " ſaid act to the contrary in any wiſe whatſoever notwithſtanding.

" PROVIDED always, and be it enacted by the authority aforeſaid, that all the gold and " ſilver, that ſhall be extracted by the aforeſaid art of melting and refining of metals, and " otherwiſe improving of them and their ores, as before ſet forth, be from henceforth im- " ployed for no other uſe or uſes whatſoever, but for the increaſe of monies; and that the " place hereby appointed for the diſpoſal thereof ſhall be their majeſties mint within the " tower of *London*; at which place they are to receive the full and true value for their gold " and ſilver ſo extracted from time to time, according to the aſſay and fineneſs thereof; and " ſo for any greater or leſſer weight: and that none of that metal of gold and ſilver, ſo re- " fined and extracted, be permitted to be uſed or diſpoſed in any other place or places within " their majeſties kingdoms and dominions.

" PROVIDED alſo, and be it further enacted by the authority aforeſaid, that no mine of " copper, tin, iron, or lead, ſhall hereafter be adjudged, reputed, or taken to be a royal " mine, although gold or ſilver may be extracted out of the ſame."

IN 1690 he gave the world his *Medicina Hydroſtatica: or Hydroſtatics applied to the* Materia Medica; *ſhewing how by the weight, that divers bodies uſed in phyſic have in water, one may diſcover, whether they be genuine or adulterate. To which is ſubjoined, A previous hydroſtatical way of eſtimating Ores*; London, in 8vo. In the *Poſtſcript* he obſerves, that when he firſt ſent to the preſs his *Medicina Hydroſtatica*, he intended " it ſhould, in the ſame book or volume, be " accompanied by another help or two, to explore and improve the *Materia Medica*. But " when, *ſays he*, the Eſſay itſelf, and the annexed Epiſtle about a previous Exploration of " Ores had been printed off, I could not but perceive, that the bulk of thoſe two tracts ſo far " exceed what I expected, that if I ſubjoined what at firſt I deſigned to add to it, it would " prove a miſ-ſhapen book, and inconvenient to be opened. Wherefore it ſeemed expedient " to divide the whole intended work in two volumes or tomes, whereof what had already " paſt the preſs ſhould make the firſt; which, that it might be the ſooner ſerviceable, ſhould " forthwith come abroad by itſelf; and the ſecond ſhould conſiſt partly of the other papers " abovementioned, as relating to the *Materia Medica*, and partly of a ſupplement to the firſt " tome, containing divers hiſtorical paralipomena, that by miſtake were omitted, and are fit " to be there ſupplied out of a fuller copy, than that, which by an overſight was made uſe " of at the preſs." But this ſecond tome never appeared. In the ſame year he publiſhed likewiſe another excellent work, entitled, *The Chriſtian Virtuoſo*; *ſhewing, that by being addicted to experimental philoſophy a man is rather aſſiſted than indiſpoſed to be a good Chriſtian. The firſt part. To which are ſubjoined,* I. *A Diſcourſe about the Diſtinction, that repreſents ſome things as above reaſon, but not contrary to reaſon.* II. *The firſt Chapters of a Diſcourſe, entitled, Greatneſs of Mind promoted by Chriſtianity.* Printed in the *Savoy*, in 8vo. In the *Advertiſement* prefixed to the *Reflections upon a Theological Diſtinction, according to which it is ſaid, that ſome Articles of Faith are above Reaſon, but not againſt Reaſon*, he obſerves, that after he had begun the *ſecond part* of the *Chriſtian Virtuoſo*, and made ſome progreſs in it, which he deſigned to continue till he had completed it, he was obliged to leave the country, where he enjoyed ſome leiſure,

[a] Statutes at large, Vol. II. p. 1545. cap. 30. edit. *London*, 1706.

and

and to remove to *London*; where ſickneſs, and buſineſs, and a multitude of viſits he could not avoid receiving, did ſo diſtract him, that theſe remora's, added to the fertility of the ſubjects, that remained to be treated of, which he found much greater than he was at firſt aware of, made him lay aſide the materials he had prepared for the *ſecond part*, to a fitter opportunity, and comply with the occaſions he had to publiſh ſome tracts, that required more. He did not live to finiſh this *ſecond part*; but the papers, which he left behind him for that purpoſe, as well as for an *Appendix* to the *firſt part*, are printed in the preſent edition.

THE year following he communicated to Monſieur *de la Croſe*, author of *the Hiſtory of Learning*, an *Account of ſome Obſervations made in the great Congregation of Waters, by lowering Bottles down into the ſea ſix hundred foot deep from the ſurface, January the 2d*, 1677-8, which was printed in that work for the month of July 1691[a], with a ſhort letter from Mr. *Boyle* to the author, in which he obſerves, that this "experiment made a great noiſe in the court of "King *Charles* II. and will, *ſays he*, reſolve all the difficulties in the queſtions, which you "propoſed to me, concerning the coldneſs of water. It was made by a captain of a ſhip, a "man of very good ſenſe, and in the preſence of a great many perſons; inſomuch that there "can be no manner of doubt concerning it."

THE laſt work, which he publiſhed himſelf, was his *Experimenta & Obſervationes Phyſicæ: wherein are briefly treated of ſeveral Subjects relating to Natural Philoſophy in an experimental Way. To which is added, a ſmall Collection of ſtrange Reports.* Part I. *London* 1691, in 8vo. The *ſecond part* never appeared.

BEING now ſenſible from the decays of his health, that his death could not be very remote, he determined upon drawing up his laſt will, which he ſigned and ſealed upon the 18th of July 1691, and of which I ſhall ſubjoin a copy in the *Appendix* to this *Life*; but before he proceeded to the perfecting of it, he wrote down the following proteſtation.

"WHEREAS I am this day about to perfect my laſt will and teſtament, I do hereby, to "prevent and ſecure myſelf from all ſcruples, ſolemnly proteſt and declare, that I do not in- "tend by ſigning and ſealing the ſaid will, or any other will or codicil, that I may hereafter "ſign, to abridge myſelf of any power, that law, or equity, or the nature of a will do or "can give me, to diſpoſe freely of all or any of my temporal concerns, even thoſe aſſigned "to pious or charitable uſes therein mentioned; and that I reſerve to myſelf a full liberty, "when this or any other teſtament ſhall be perfected, to annul, revoke, or alter the whole "will, or any part of it, and diſpoſe otherwiſe of my concerns, as freely, as if the ſaid will, "or any part or codicil of it, had never been ſigned and publiſhed, or ſo much as intended "by me. Witneſs my hand this 18th day of July 1691.

"RO. BOYLE.

"Witneſs
"JOHN WARR."

IN October following we find by a letter of his, dated the 8th of that month, to Dr. *Turberville* of *Saliſbury*[b], that his ſiſter the lady *Ranelagh* and himſelf were extremely ill; and he particularly complains of a diſtemper in his eyes, which greatly ſurprized and afflicted him, having continued with him for about a month. "The caſe in ſhort, *ſays he*, is this: "in the day time, I ſee, thanks be to God, as I uſe to do, and ſo till five o'clock in the af- "ternoon; but then, as ſoon as candles are brought in, I find a very ſenſible decay in my "ſight; ſo that though I can ſee all the ſame groſs objects, as I did before, and could, if I "durſt, read printed books, as I have often tried, yet the reflection from thoſe objects is not "vivid, as it was wont to be; and if I look upon ſomewhat diſtant objects, methinks I ſee "them through a thin miſt, or a little ſmoke; but when the candles are newly ſnuffed, and "ſo the light encreaſed, I ſee far better for a little while, till it begin to have more ſnuff. "This diſtemper continues as long as I make uſe of candle-light; but the next morning, "by God's goodneſs, I find myſelf as before; only now and then there ſeems to fall ſlowly "down, ſometimes in one eye, and ſometimes in another, a faintly ſhining vapour, which "immediately diſappears. I have ſuch apparitions, of late, for theſe two or three years, "without any bad conſequence. What this diſtemper may proceed from, I know not, though "I remember I have heard you more than once take notice of the narrowneſs of my pupil. "Sight is a thing ſo dear to all men, and eſpecially to ſtudious perſons, that I earneſtly beg "you would be pleaſed to conſider my caſe deliberately, and acquaint me with your thoughts "of the cauſe; and more particularly to ſend preſcriptions of the receipts you would have "me employ, and your directions what elſe you would have me do towards the cure of it.— "I forgot to tell you, that for ſome months laſt paſt I have been much troubled with what "they call vapours, or fumes of the ſpleen, and with ſome ſcorbutic diſaffections."

HIS ſiſter *Ranelagh*'s indiſpoſition at length terminated in her death, on the 23d of December following; and the loſs of ſuch a perſon was perhaps as fatal to him as it was important to the world. She had lived the longeſt on the moſt public ſcene, and made the greateſt figure in all the revolutions of theſe kingdoms for above fifty years, of any woman

[a] Pag. 57, 58.

[b] Vol. V. p. 246, 247.

of that age. She employed her whole time, intereſt, and eſtate, in doing good to others; and as her great underſtanding, and the vaſt eſteem ſhe was in, made all perſons in their ſeveral turns of greatneſs deſire and value her friendſhip, ſo ſhe gave herſelf a clear title to uſe her intereſt with them for the ſervice of others, by this, that ſhe never made any advantage of it to any end or deſign of her own. She was contented with what ſhe had; and though ſhe was twice ſtript of it, ſhe never moved on her own account, but was the general interceſſor for all perſons of merit or in want. This had in her the better grace, and was both more Chriſtian and more effectual, becauſe it was not limited within any narrow compaſs of parties or relations. When any party was depreſſed, ſhe had credit and zeal enough to ſerve them; and ſhe employed that ſo effectually, that in the next turn ſhe had a new ſtock of credit, which ſhe laid out wholly in that *labour of love*, in which ſhe ſpent her life. And though ſome particular opinions might ſhut her up in a divided communion, yet her ſoul was never of a party. She divided her charities and friendſhips, her eſteem as well as her bounty, with the trueſt regard to merit and her own obligations, without any difference made upon the account of opinion. She had, with a vaſt reach both of knowledge and apprehenſion, an univerſal affability and eaſineſs of acceſs; an humility, that deſcended to the meaneſt perſons and concerns, an obliging kindneſs and readineſs to adviſe thoſe, who had no occaſion for any further aſſiſtance from her. And with all theſe and many other excellent qualities ſhe had the deepeſt ſenſe of religion, and the moſt conſtant turning of her thoughts and diſcourſes that way, that was known perhaps in that age. Such a ſiſter became ſuch a brother; and it was but ſuitable to both their characters, that they ſhould have improved the relation, under which they were born, to the more exalted and endearing one of friend[a]. And as they were *pleaſant in their lives, in their death they were not divided*; for as he had lived with her for the greateſt part of forty ſeven years, ſo he did not ſurvive her above a week, for he died in the ſixty fifth year of his age, on wedneſday, December 30, 1691. at three quarters of an hour after twelve at night [b], and was interred on the 7th of January following, at the upper end of the ſouth ſide of the chancel of St. *Martin's in the Fields* in *Weſtminſter*, near the body of his ſiſter *Ranelagh*, his funeral ſermon being preached by Dr. *Gilbert Burnet*, biſhop of *Saliſbury*, upon this text, *Eccleſ.* ii. 26. *For God giveth to a man, that is good in his ſight, wiſdom, knowledge, and joy.* His funeral was decent; and though without pomp, yet honoured with a great appearance of perſons of the higheſt diſtinction, beſides his own numerous relations.

BEFORE I proceed to his character, I ſhall inſert an account of his poſthumous works, which were as follows.

I. *The General Hiſtory of the Air deſigned and begun.* Printed at *London*, 1692, in 4to. Mr. *Locke*, in a letter to *William Molyneux*, Eſq; dated December 26, 1692, obſerves, that "though this treatiſe was left imperfect, yet, I think, *ſays he*, the very deſign of it will "pleaſe you; and it is caſt into a method, that any one, who pleaſes, may add to it under "any of the ſeveral titles, as his reading or obſervation ſhall furniſh him with matter of fact. "If ſuch men as you are, curious and knowing, would join to what Mr. *Boyle* had collected "and prepared, what comes in their way, we might hope in ſome time to have a conſiderable hiſtory of the air, than which I ſcarce know any part of natural philoſophy would "yield more variety and uſe. But it is a ſubject too large for the attempts of any one man, "and will require the aſſiſtance of many hands to make it a hiſtory very ſhort of complete." Mr. *Molyneux*, in his anſwer, dated March 2, 1692-3, writes thus: "I am extremely obliged "to you for Mr. *Boyle's* book of the air, which lately came to my hands. It is a vaſt deſign, and not to be finiſhed but by the united labours of many heads, and indefatigably "proſecuted for many years; ſo that I deſpair of ſeeing any thing complete therein. However, if many will lend the ſame helping hands, that you have done, I ſhould be in hopes; "and certainly there is not a chapter in all natural philoſophy of greater uſe to mankind, "than what is here propoſed.

II. *Medicinal Experiments: or a Collection of choice remedies, for the moſt part ſimple and eaſily prepared: London* 1692, in 12mo. This is a *ſecond edition* of the *Receipts ſent to a Friend in America:* printed in 1688, with a new preface, and the addition of a *ſecond part*, or the latter five decads. Theſe were again reprinted in 1696, and called the *firſt* and *ſecond* volume; and in 1698 a *third volume* was added to them.

III. *General Heads for the Natural Hiſtory of a country great or ſmall, drawn out for the Uſe of Travellers and Navigators.* To which are added, *Other Directions for Navigators, &c. with particular Obſervations of the moſt noted Countries in the World. By another Hand. London* 1692, in 12mo. Theſe *General Heads* were firſt printed in the *Philoſophical Tranſactions*, No. II. p. 186. No. XVIII. p. 315. No. XIX. p. 330. being drawn up by Mr. *Boyle*, at the requeſt of the Royal Society. The other directions added in this edition were drawn up by various perſons at divers times, by order of the *Royal Society*, and printed in different numbers of the *Philoſophical Tranſactions*; but being in purſuance of the plan ſketched out by Mr. *Boyle*, were very properly annexed to the preceding ones.

IV. *A paper of the honourable* Robert Boyle's, *depoſited with the Secretaries of the Royal Society. Octob.* 14, 1680, *and opened ſince his death; being an Account of his making the Phoſphorus, &c.*

[a] Biſhop *Burnet's* Funeral Sermon on Mr. *Boyle*, p. 33, 34.

[b] Mr. *Warr's* MSS.

September 30, 1680. Printed in the *Philoſophical Tranſactions*, No. CXCVI. p. 583. anno 1692-3.

V. *An Account of a Way of examining Waters, as to freſhneſs and ſaltneſs. To be ſubjoined as an Appendix to a lately printed Letter about ſweetned Water: October* 30, 1683: publiſhed in the *Philoſ. Tranſact.* No. CXCVII. p. 627.

VI. *A Free Diſcourſe againſt Cuſtomary Swearing, and a Diſſuaſive from Curſing. London* 1695, in 8vo.

VII. *Medicinal Experiments: or a Collection of choice remedies, chiefly ſimple and eaſily prepared; uſeful in Families, and fit for the Service of Country People. The third and laſt Volume, publiſhed from the Author's original MSS. Whereunto is added, ſeveral other uſeful notes, explicatory of the ſame. London* 1698, in 12mo. This and the two preceding volumes have been ſince ſeveral times reprinted all together.

MR. *Boyle* was tall of ſtature, but ſlender, and his countenance pale and emaciated[a]. His conſtitution was ſo tender and delicate, that he had divers ſorts of cloaks to put on, when he went abroad, according to the temperature of the air; and in this he governed himſelf by his thermometer[b]. He eſcaped indeed the ſmall pox during his life[c]; but for almoſt forty years he laboured under ſuch a feebleneſs of body, and ſuch lowneſs of ſtrength and ſpirits, that it was aſtoniſhing, how he could read, meditate, try experiments, and write as he did. He had likewiſe a weakneſs in his eyes, which made him very tender of them, and extremely apprehenſive of ſuch diſtempers as might affect them. He imagined alſo, that if ſickneſs ſhould confine him to his bed, it might raiſe the pains of the ſtone to a degree, which might be above his ſtrength to ſupport; ſo that he feared leſt his laſt minutes ſhould prove too hard for him. This was the ground of all the caution and apprehenſion, which he was obſerved to live in. But as to life itſelf, he had that juſt indifference to it, which became ſo true a Chriſtian. However, his ſight began not to grow dim above four hours before he died; and when death came upon him, he had not been above three hours in bed, before it made an end of him with ſo little pain, that it was plain the light went out merely for want of oil to maintain the flame[d]. The ſimplicity of his diet was in all appearance that, which preſerved him ſo long beyond all men's expectation. This he practiſed ſo ſtrictly, that in a courſe of above thirty years he neither eat nor drank to gratify the varieties of appetite, but merely to ſupport nature; and was ſo regular in it, that he never once tranſgreſſed the rule, meaſure, and kind, which were preſcribed him[e].

IN his firſt addreſſes, when he was to ſpeak or anſwer, he ſometimes heſitated a little, rather than ſtammered, or repeated the ſame word; and this, as it rendered him ſlow and deliberate, ſo after the firſt effort he proceeded without the leaſt interruption in his diſcourſe[f].

HE was never married; but Mr. *Evelyn* was aſſured, that he courted the beautiful and ingenious daughter of *Cary*, earl of *Monmouth*; and that to this paſſion was owing his *Seraphic Love*[g]. But it does not appear from any of his papers, that he had ever entertained the leaſt thoughts of that kind; and he wrote the following letter, when he was very young, to the lady *Barrimore*, his niece, upon a report of his being actually married, of which that lady had informed him.

" * * * It is high time for me to haſten the payment of the thanks I owe your ladyſhip " for the joy you are pleaſed to wiſh me, and of which that wiſh poſſibly gives me more " than the occaſion of it would. You have certainly reaſon, madam, to ſuſpend your " belief of a marriage celebrated by no prieſt but fame, and made unknown to the ſup- " poſed bridegroom. I may poſſibly e're long give you a fit of the ſpleen upon this theme; " but at preſent it were incongruous to blend ſuch pure raillery, as I ever prate of matri- " mony and amours with, among things I am ſo ſerious in as thoſe this ſcribble preſents you. " I ſhall therefore only tell you, that the little gentleman and I are ſtill at the old defiance. " You have carried away too many of the perfections of your ſex, to leave enough in this " country for the reducing ſo ſtubborn a heart as mine, whoſe conqueſt were a taſk of ſo " much difficulty, and is ſo little worth it, that the latter property is always likely to deter " any, that hath beauty and merit enough to overcome the former. But though this un- " tamed heart be thus inſenſible to the thing itſelf called love, it is yet very acceſſible to " things very near of kin to that paſſion; and eſteem, friendſhip, reſpect, and even admi- " ration, are things, that their proper objects fail not proportionately to exact of me, and " conſequently are qualities, which in their higheſt degrees are really and conſtantly paid " my lady *Barrimore* by her

" Moſt obliged humble ſervant,

" and affectionate uncle,

" ROBERT BOYLE."

[a] Letter of *John Evelyn*, Eſq; to Dr. *Wotton*, March 29, 1696. [b] Information of Sir *Hans Sloan*, Bart.
[c] Letter of the Rev. Mr. *Kirkwood* to Mr. *Boyle*, dated July 13, 1689. [d] *Burnet*'s Funeral Sermon, p. 31.
[e] Id. ibid. [f] Mr. *Evelyn*'s letter of March 29, 1696. [g] Ibid.

IN

IN the memorandums of Mr. *Boyle*'s life, ſet down by biſhop *Burnet*, it is remarked, that he *abſtained from purpoſes of marriage, at firſt out of policy, afterwards more philoſophically; and upon a general propoſition with many advantages, he would not know the perſon's name.* And we find by a letter of Dr. *John Wallis* to him, dated at *Oxford*, July 17, 1669[a], that he had an overture made to him with reſpect to the lady *Mary Haſtings*, ſiſter to the earl of *Huntingdon*, and eminent for her admirable temper, great piety, and uncommon underſtanding, with every other accompliſhment proper to make him an excellent wife. But he ſtill perſiſted in his firſt reſolution of living ſingle, though few men were more facetious and agreeable in converſation with the ladies, whenever he happened to be engaged among them[b]. And indeed ſometimes, upon other occaſions, he diſtinguiſhed himſelf by ſo copious and lively a flow of wit, that Mr. *Cowley*, and Sir *William Davenant*, both thought him equal in that reſpect to the moſt celebrated genius's of that age[c].

HE had ſo profound a veneration for the Deity, that the very name of God was never mentioned by him without a pauſe and a viſible ſtop in his diſcourſe; in which Sir *Peter Pett*[d], who knew him for almoſt forty years, affirms, that he was ſo exact, that he did not remember to have obſerved him once to fail in it. He was very conſtant and ſerious in his ſecret addreſſes to God; and it appeared to thoſe, who converſed moſt with him in his enquiries into nature, that his main deſign in that, on which as he had his own eye moſt conſtantly, ſo he took care to put others often in mind of it, was to raiſe in himſelf and others more elevated thoughts of the greatneſs and glory, and of the wiſdom and goodneſs of the Deity[e]. This was ſo deep in his mind, that he concludes the article of his will, which relates to the Royal Society, in theſe words: *Wiſhing them alſo a happy ſucceſs in their laudable attempts to diſcover the true nature of the works of God, and praying, that they and all other ſearchers into phyſical truths, may cordially refer their attainments to the glory of the great Author of Nature, and to the comfort of mankind.* For this purpoſe he founded his lecture in the city of *London*, charging, by a codicil annexed to his will, and dated *July* 28, 1691, his meſſuage or dwelling-houſe in St. *Michael*'s *Crooked-Lane*, in that city, with the payment of the clear yearly rents and profits thereof to ſome learned divine in *London*, or within the bills of mortality, to be elected for a term not exceeding three years by Dr. *Teniſon*, afterwards archbiſhop of *Canterbury*, Sir *Henry Aſhurſt*, Sir *John Rotheram*, and *John Evelyn*, Eſq. The buſineſs, which he appointed thoſe lecturers, was, among others, *to be ready to ſatisfy real ſcruples, and to anſwer ſuch new objections and difficulties, as might be ſtarted, to which good anſwers had not been made*; and alſo *to preach eight ſermons in the year, the firſt monday of January, February, March, April, and May, and of September, October, and November.* The ſubject of theſe ſermons was to be *the proof of the Chriſtian Religion againſt notorious Infidels, viz. Atheiſts, Theiſts, Pagans, Jews, and Mahometans, not deſcending lower to any controverſies, that are among Chriſtians.* But by reaſon the lectures were ſeldom continued above a year, and that the houſe ſometimes ſtood empty, and tenants broke, or failed in due payment of their rent, therefore the ſalary ſometimes remained long unpaid, or could not be gotten without ſome difficulty. To remedy which inconvenience, archbiſhop *Teniſon* procured a yearly grant of 50 pounds to be paid quarterly for ever, charged upon a farm in the pariſh of *Brill*, in the county of *Bucks*; which ſtipend is accordingly very duly paid, when demanded, without fee or reward[f].

HE was likewiſe at the charge of the tranſlation and impreſſion of the *Four Goſpels* and *Acts of the Apoſtles* into the Malayan language, as I have remarked above; and this book he ſent over all the *Eaſt-Indies*. He gave a noble reward to Dr. *Edward Pococke*, who tranſlated *Grotius*'s incomparable treatiſe *of the Truth of the Chriſtian Religion* into Arabic, and was at the charge of a whole impreſſion, which was finiſhed at *Oxford* in 1660, in 4to, and which he took care to order to have diſperſed in all the countries, where that language is underſtood. He was reſolved to have carried on the impreſſion of the New Teſtament in the Turkiſh language; but the Company thought, that it became them to perform that work, and ſo ſuffered him only to give a large ſhare towards it[g]. He was at 700 pounds charge in the edition of the *Iriſh* bible, which he ordered to be diſtributed in *Ireland*[h]; a particular account of which will appear from the *Appendix*, No. III.

HE contributed largely alſo to the impreſſions both of the Welch bible, and of the Iriſh bible, for the uſe of the *High-Lands* in *Scotland*, as may be likewiſe ſeen in the *Appendix*, No. IV.

HE gave, during his life, 300 pounds to advance the deſign of propagating the Chriſtian religion in *America*; and his zeal and generoſity in that reſpect are acknowledged in many letters of Mr. *Eliot*, of *New-England*; which are given in the *Appendix*, No. V.

HE was no leſs a friend to that colony in their civil affairs, as appears by letters of thanks ſigned by the governor, *&c.* ſent to him, and printed in the *Appendix*, No. VI.

[a] Vol. V. p. 514, 515. [b] Mr. *Evelyn*'s letter of March 29, 1696. [c] Sir *Peter Pett*'s papers relating to Mr. *Boyle*. [d] Ibid. [e] *Burnet*'s Funeral Sermon, p. 25. [f] See the note upon Dr. *Will. Derham*'s dedication of his *Phyſico-Theology*, fifth edit. *London* 1720, in 8vo. [g] *Burnet*'s Funeral Sermon, p. 26. [h] Id. ibid. See likewiſe *Burnet*'s Life of Dr. *Will. Bedell*, biſhop of *Kilmore*, p. 136, 137. Edit. *London* 1685, in 8vo.

HE

HE had the greateſt regard for the clergy, of which he gave many inſtances. When he underſtood, what ſhare he had in impropriations, he ordered very large gifts to be made to the incumbents in thoſe pariſhes, and to the widows of ſuch, as died before he had reſolved upon this charity. A perſon, who was concerned in two diſtributions, which were made, declared, that the ſums upon thoſe two occaſions amounted to near 600 l. *And another very liberal one*, ſays biſhop *Burnet*[a], *is alſo ordered by his will, but in an indefinite ſum; I ſuppoſe, by reaſon of the preſent condition of eſtates in* Ireland; *ſo plentifully did he ſupply thoſe, who ſerved at the altar out of that, which was once devoted to it, though it be now converted to a temporal eſtate.* It appears likewiſe, by a letter of his to one of his ſtewards in *Ireland*, dated January 22, 1684-5, that he had ordered a former ſteward to ſet aſide every year about a fifth part (rather more than leſs) of the clear annual income of his tythes and impropriations, to be employed in pious uſes. The orders to the new ſteward run thus: "I muſt deſire you at every "half year's rent day, or when the rents then due ſhall be paid in to you, to lay aſide, till "you receive contrary orders, the full fifth part of what you judge you receive for me *de* "*claro* upon the account of tythes and impropriations, to be diſpoſed, *&c.* And in a letter of Sir *Robert Southwel* to him from *Kingſale*, March 20, 1675[b], are theſe words: *It has often come into my mind, and indeed I thought, that I had accordingly wrote lately of it, that concern of yours, which long ſince you were pleaſed to honour me with the truſt and care of, I mean, that ſtock of money, which, out of your great bounty and charity, you were pleaſed to diſtribute amongſt thoſe miniſters, that had ſerved the cures upon your impropriate eſtate in this kingdom, and of the diſtribution of which I did long ſince return you an account, and alſo what balance remained unto you, after ſatisfying all the concerned, which was forty five pounds, &c.* I find alſo, by a liſt of names, which he had procured, together with ſeveral letters of thanks ſent him out of *Wales*, that he extended his diffuſive charity to ſuch poor nonconformiſt miniſters there, as were men of piety and good learning.

HE was conſtant to the eſtabliſhed church, and went to no ſeparate aſſemblies, how charitably ſoever he might think of their perſons, and how plentifully ſoever he might have relieved their neceſſities[c]. He had once indeed, before the reſtoration, as he told Sir *Peter Pett*[d], the curioſity, to go to Sir *Henry Vane*'s houſe, and there heard him preach in a large thronged room a long ſermon, on the text of *Dan.* xii. 2. *And many of them that ſleep in the duſt of the earth ſhall awake, ſome to everlaſting life, and ſome to ſhame and everlaſting contempt.* The whole ſcope of Sir *Henry*'s ſermon was to ſhew, that many doctrines of religion, that had long been dead and buried in the world, ſhould before the end of it be awakened into life; and that many falſe doctrines being then likewiſe revived, ſhould, by the power of truth, be then doomed *to ſhame and everlaſting contempt.* When Sir *Henry* had concluded his diſcourſe, Mr. *Boyle* ſpoke to this effect to him before the people; That being informed, that in ſuch private meetings it was not uncuſtomary for any one of the hearers, who was unſatisfied about any matters there uttered, to give in his objections againſt them, and to prevent any miſtakes in the ſpeakers or hearers; he thought himſelf obliged for the honour of God's truth to ſay, that this place in *Daniel* being the cleareſt one in all the old teſtament for the proof of the reſurrection, we ought not to ſuffer the meaning of it to evaporate into allegory; and the rather, ſince that inference is made by our Saviour in the new teſtament by way of aſſerting the reſurrection from that place of *Daniel* in the old. And that if it ſhould be denied, that the plain and genuine meaning of thoſe words in the Prophet is to aſſert the reſurrection of dead bodies, he was ready to prove it to be ſo, both out of the words of the text and context in the original language, and from the beſt expoſitors both Chriſtian and Jewiſh. But that if this be not denied, and Sir *Henry*'s diſcourſe of the reſurrection of doctrines true and falſe was deſigned by him only in the way of occaſional meditations from thoſe words in *Daniel*, and not to enervate the literal ſenſe as their genuine one, then he had nothing further to ſay. Mr. *Boyle* then ſitting down, Sir *Henry* roſe up and ſaid, that his diſcourſe was only in the way of ſuch occaſional meditations, which he thought edifying to the people; and declared, that he agreed, that the literal ſenſe of the words was the reſurrection of dead bodies; and ſo that meeting broke up. Mr. *Boyle* afterwards ſpeaking of this conference to Sir *Peter Pett*, obſerved, that Sir *Henry Vane* at that time being in the height of his authority in the ſtate, and his auditors at that meeting conſiſting chiefly of dependents on him and expectants from him, the fear of loſing his favour would probably have reſtrained them from contradicting any of his interpretations of ſcripture, how ridiculous ſoever. "But I (ſaid Mr. *Boyle*) having "no little awes of that kind upon me, thought myſelf bound to enter the liſts with him, as "I did, that the ſenſe of the ſcriptures might not be depraved."

HE had poſſeſſed himſelf with ſuch an amiable view of Chriſtianity, ſeparated from either ſuperſtitious practices or the ſourneſs of parties, that as he was fully perſuaded of the truth of it, he rejoiced in every diſcovery, which nature furniſhed him with to illuſtrate it, or to take off the objections againſt any part of it. He always conſidered it as a ſyſtem of truths, which ought to purify the hearts, and govern the lives of thoſe, who profeſs it. He loved no practice, which ſeemed to leſſen that, nor any nicety, which occaſioned diviſions amongſt Chriſtians. He thought, that pure and diſintereſted Chriſtianity was ſo bright and glorious a ſyſtem, that he was much troubled at the diſputes and diviſions, which had riſen about ſome

[a] Funeral Sermon, p. 27. [b] Vol. V. p. 406. [c] *Burnet*'s Funeral Sermon, p. 29. [d] Sir *Peter Pett*'s papers relating to Mr. *Boyle*.

leſſer

leſſer matters, while the great and the moſt important, as well as moſt univerſally acknowledged truths were by all ſides almoſt as generally neglected, as they were confeſſed [a]. He loved no narrow thoughts, no low or ſuperſtitious opinions in religion; and therefore as he did not ſhut himſelf within a party, ſo neither did he ſhut any party out from him [b]. His zeal was lively and effectual in the greateſt and trueſt concerns of religion; but he avoided to enter far into the unhappy breaches, which had long weakened as well as diſtracted Chriſtianity, any otherwiſe, than to have a great averſion to all thoſe opinions and practices, which ſeemed to him to deſtroy morality and charity. He had a moſt particular zeal againſt all ſeverities and perſecution upon the account of religion; *and I have ſeldom*, ſays biſhop *Burnet* [c], *obſerved him to ſpeak with more heat and indignation, than when that came in his way. He did thoroughly agree with the doctrines of our church, and conform to our worſhip; and he approved of the main of our conſtitution; but he much lamented ſome abuſes, that he thought remained ſtill among us.* And Dr. *Thomas Dent*, prebendary of *Weſtminſter*, who was a particular friend of his, obſerves [d], that "he always heard him expreſs his judgment and inclination to the "church of *England*; but he was for moderation to thoſe, who diſſented from us, and not "to force tender conſciences, for which he ſeemed to expreſs great averſeneſs. He had fre-"quent conferences on this ſubject with the preſent archbiſhop [*Teniſon*], biſhop of *Sarum* "[*Burnet*], but particularly the late biſhop of *Worceſter*, the learned Dr. *Stillingfleet*, "for whoſe depth of learning and ſolid judgment he had always the greateſt value and "eſteem." Sir *Peter Pett* likewiſe affirms, that he was peculiarly warm in his expreſſions againſt perſecution on account of religion; and relates, that ſoon after the reſtoration Mr. *Boyle* and he diſcourſing of the ſeverities practiſed by the biſhops towards the Puritans in the reign of King *Charles* I. and of thoſe, which were returned upon the epiſcopal divines, during the following uſurpations; and being apprehenſive, that the reſtored clergy might be tempted by their late ſufferings to ſuch a vindictive retaliation, as would be contrary to the true meaſures of Chriſtianity and politics, they came at laſt to an agreement, that it would tend to the public good, to have ſomething written and publiſhed in defence of liberty of conſcience. Mr. *Boyle* undertook to engage Dr. *Thomas Barlow*, whoſe judgment in that point he very well knew, to treat of the theological part of the queſtion; and deſired Sir *Peter* to write of the political part; which the latter conſented to, on condition, that Mr. *Boyle* would let him read his manuſcript to him before it was committed to the preſs, and give him his opinion about the whole. Mr. *Boyle* frankly promiſed this, and was willing to ſtate the fact of the allowance of liberty of conſcience in foreign parts. But afterwards conſidering, that Mr. *John Dury*, who had ſpent many years in his travels, eſpecially in the northern parts of *Europe*, when he was engaged in his ſcheme for reconciling the Lutherans and Calviniſts, was capable of writing on that ſubject with more extent and exactneſs, than himſelf, he prevailed upon Mr. *Dury* to write upon it, and rewarded him for it, and delivered the treatiſe drawn by him to Sir *Peter*, who publiſhed it at the end of his own in 1660, (though the bookſellers, according to their cuſtom, antedated in the title page 1661,) and inſcribed both thoſe treatiſes with the laſt letters only of the writers names. But he did not print Dr. *Barlow*'s diſcourſe upon the ſame ſubject, becauſe as, on the one hand, it would not, how ſtrong ſoever its reaſonings were, be ſufficient to reſtrain the rigorous meaſures reſolved upon againſt the Nonconformiſts, ſo, on the other, it might expoſe the doctor to the reſentment of his brethren, whom he had offended by writing, juſt before the reſtoration, a letter to Mr. *John Tombes*, the famous Anabaptiſt, in which he had expreſſed ſome prejudice againſt the practice of infant-baptiſm, and by refuſing, even after the reſtoration, to retract that letter, notwithſtanding he was in danger of loſing, by that refuſal, his ſtation in the univerſity of *Oxford*, and all his hopes of future preferment. However his diſcourſe abovementioned was publiſhed after his death under the title of *The Caſe of a Toleration in Matters of Religion*, in a collection, intitled, *Several miſcellaneous and weighty Caſes of Conſcience learnedly and judiciouſly reſolved by the Right Reverend Father in God*, Dr. Thomas Barlow, *late Lord Biſhop of* Lincoln; printed at *London* 1692, in 8vo.

MR. *Boyle*'s charity to thoſe, who were in want, and his bounty to all learned men, who were put to wreſtle with neceſſities, were very extraordinary. Great ſums went eaſily from him without the partialities of ſect, country, or relations; for he conſidered himſelf as a part of the human nature, and a debtor to the whole race of men. He took care to do this ſo ſecretly, that even thoſe, who knew all his other concerns, could never find out what he did that way. And indeed he was ſo ſtrict to our Saviour's precept, that except the perſons themſelves, or ſome one, whom he truſted to convey it to them, no body ever knew how that great ſhare of his eſtate, which went away inviſibly, was diſtributed; even he himſelf kept no account of it, for that he thought might fall into other hands [e]. "I ſpeak (ſays biſhop "*Burnet* [f]) upon full knowledge on this article, becauſe I had the honour to be made uſe of "by him in it. If thoſe, that have fled hither from the perſecutions of *France*, or from the "calamities of *Ireland*, feel a ſenſible ſinking of their ſecret ſupplies, with which they were "often furniſhed, without knowing from whence they came, they will conclude, that they "have loſt not only a purſe, but an eſtate, that went ſo very liberally among them, that I "have reaſon to ſay, that for ſome years his charity went beyond a thouſand pounds a year."

HE was very plain, unaffected, and temperate in the manner of his life, and had about him

[a] *Burnet*'s Funeral Sermon, p. 25, 26. [b] Ibid. p. 29. [c] Ibid. p. 27. [d] Letter to Dr. *William Wotton*, of May 20, 1699. [e] *Burnet*'s Funeral Sermon, p. 31. [f] Ibid. p. 32.

all that neglect of pomp in clothes, lodging, furniture, and equipage, which agreed with his grave and ſerious courſe of life [a].

He was extremely candid and courteous in his converſation. His conſtitution indeed inclined him to be choleric; but he gained ſo perfect an aſcendant over this paſſion, that it never appeared, except ſometimes in his countenance upon a very high provocation [b]. He had brought his mind to ſuch a freedom, that he was not apt to be impoſed upon; and his modeſty was ſuch, that he did not dictate to others, but propoſed his own ſenſe with a due and decent diſtruſt, and was ever ready to hearken to what was ſuggeſted to him by others. When he differed from any, he expreſſed himſelf in ſo humble and ſo obliging a way, that he never treated things or perſons with neglect; and he was never known to have offended any perſon in his whole life by any part of his deportment. For if at any time he ſaw cauſe to ſpeak roundly to any, it was never in paſſion, or with any reproachful or indecent expreſſions. And as he was careful to give thoſe, who converſed with him, no cauſe or colour for diſpleaſure; ſo he was yet more careful of thoſe, who were abſent, never to ſpeak ill of any. If the diſcourſe began to be hard upon any perſon, he was immediately ſilent; and if the ſubject was too long dwelt upon, he would at laſt interpoſe, and between reproof and raillery divert it [c].

Whatever he was in the ſight of men, how pure and ſpotleſs ſoever his character appeared to the world, he was in reality the ſame in his moſt ſecret receſſes. He affected nothing, which was ſolemn or ſupercilious, nor uſed any methods to make multitudes run after him, or depend upon him. It was never diſcovered, that there was any thing hid under all this appearance of goodneſs, which was not truly ſo; for he concealed both his piety and charity all he could, and lived in the due methods of civility, and would never aſſume the authority, which all the world was ready to pay him. He allowed himſelf a great deal of decent chearfulneſs, without the leaſt tincture of that moroſeneſs, to which philoſophers think they have ſome right; nor of thoſe affectations, which men of an extraordinary pitch of devotion ſometimes run into, without being well aware of them. He had indeed nothing of frolic and levity in him; he had no reliſh for the idle and extravagant madneſs of the men of pleaſure. He did not waſte his time, nor diſſipate his ſpirits in fooliſh mirth; but he poſſeſſed his own ſoul in patience, full of that ſolid joy, which his goodneſs as well as his knowledge afforded him. He, who had neither deſigns nor paſſions, was capable of little trouble from any concerns of his own. He had about him all the tenderneſs of good nature, as well as all the ſoftneſs of friendſhip. Theſe gave him a large ſhare of other men's concerns; for he had a quick ſenſe of the miſeries of mankind. He had alſo a feeble body, which needed to be looked to the more, becauſe his mind went faſter than his body could keep pace with it. Yet his great thoughts of God, and his contemplation of his works, were to him ſources of continual joy, which never could be exhauſted. The ſenſe of his own integrity, and of the good, which he found it did, afforded him the trueſt of all pleaſure, *ſince they gave him*, ſays biſhop *Burnet* [d], *the certain proſpect of that fulneſs of joy, in the ſight of which he lived ſo long.*

He ſpake of the government, even in times, which he diſliked, and upon occaſions, which he ſpared not to condemn, with an exactneſs of reſpect [e]. King *Charles* II. King *James* II. and King *William*, were ſo highly pleaſed with his converſation, that they often uſed to diſcourſe with him with great familiarity. His four elder brothers being all noblemen, he was ſeveral times offered a peerage, which he conſtantly refuſed to accept [f]; but he procured a title, which, without derogating from the dignity of Kings, muſt be acknowledged to be beyond their prerogative [g]. He had too unblemiſhed a candor, to be capable of thoſe arts and practices, which the world generally terms wiſdom. He could neither lie nor equivocate, but could well be ſilent; and by practiſing that much, he covered himſelf upon many uneaſy occaſions. He made true judgments of men and things; and his advices were ſolid and ſound; and if caution and modeſty gave too ſtrong a bias, his invention was fruitful to ſuggeſt good expedients. He had great notions of what human nature might be brought to; but ſince he ſaw mankind not capable of them, he withdrew himſelf early from courts and affairs, *notwithſtanding the diſtinction*, ſays biſhop *Burnet* [h], *with which he was always uſed by our late Princes.* He had the principles of an Engliſhman, as well as of a proteſtant, too deep in him to be corrupted, or to be cheated out of them; and in theſe he ſtudied to fortify all who converſed much with him. He had a very particular ſagacity in obſerving what men were fit for; and had ſo vaſt a ſcheme of different performances, that he could eaſily furniſh every man with work, who had leiſure and capacity for it; and as ſoon as he ſaw him engaged in it, then an handſom preſent was made, to enable him to go on with it [i].

The reputation, which he had acquired among foreign nations, was ſo great, that no ſtrangers, who came among us, and had any taſte for learning or philoſophy, left *England* without ſeeing him. He received them with a certain openneſs and humanity, which were peculiar to him; and though theſe viſits made a great waſte of his time, yet as he was ſtrict in not ſuffering himſelf to be denied, when he was at home, ſo he ſaid, that he knew the heart of a ſtranger, and how much eaſed his own had been, while he was travelling, if admitted to the converſation of thoſe, whom he deſired to ſee; and therefore he thought, that

[a] *Burnet*'s Funeral Sermon, p. 30. [b] *Burnet*'s MS. papers. [c] *Burnet*'s Funeral Sermon, p. 29, 30. [d] Id. p. 38. [e] Id. p. 35. [f] *Budgell*'s Life of the Earl of *Orrery*, p. 145. [g] *Burnet*'s Funeral Sermon, p. 23. [h] Ibid. p. 35, 36. [i] Ibid. p. 36.

his obligation to ſtrangers was more than mere civility, and that it was a point of religious charity in him [a].

HIS knowledge was of prodigious extent. He was a great maſter of the *Greek* language, and read the new teſtament in the original with ſuch attention, that he could have quoted it almoſt as readily as the Engliſh verſion [b]. He carried the ſtudy of the Hebrew tongue very far into the Rabbinical writings; and drew up a grammar in it for his own uſe. He learned likewiſe the Chaldee and Syriac, and would have gained a thorough knowledge of the Arabic, if the infirmity of his eyes had not interrupted his progreſs in it [c]. He had read ſo much of the Fathers, that he had formed out of it a clear judgment of all the eminent ones. He had read over a vaſt number of commentators on the ſcriptures, and had gone with great exactneſs through the whole controverſies of religion, and had a juſt idea of the intire body of divinity. He run the whole compaſs of the mathematical ſciences; and though he did not ſet up for an inventor in them, yet he knew even the abſtruſeſt parts of geometry. Geography in the ſeveral branches of it, which related to navigation or travelling, hiſtory, and books of travels, were his diverſions. He went very accurately through all the parts of phyſic; only the tenderneſs of his nature made him leſs able to endure the exactneſs of anatomical diſſections, eſpecially of living animals, though he knew theſe to be moſt inſtructing. But for the hiſtory of nature ancient and modern, of the productions of all countries, of the virtues and improvements of plants, ores, and minerals, and all the varieties, which are in them in different climates, his knowledge was unrivalled in that age [d]. But his peculiar and favourite ſtudy was chemiſtry, "in which, *ſays biſhop* Burnet [e], he engaged with none of "thoſe ravenous and ambitious deſigns, that drew many into them. His deſign was only to "find out nature, to ſee into what principles things might be reſolved, and of what they "were compounded, and to prepare good medicaments for the bodies of men. He ſpent "neither his time nor his fortune upon the vain purſuits of high promiſes and pretenſions He "always kept himſelf within the compaſs, that his eſtate might well bear. And as he made "chemiſtry much the better for his dealing in it, ſo he never made himſelf the worſe or the "poorer for it. It was a charity to others, as well as an entertainment to himſelf; for the "produce of it was diſtributed by his ſiſter, and others, into whoſe hands he put it." His laboratory was conſtantly open to the curious, whom he permitted to ſee moſt of his proceſſes. It is true, he found out ſome things, in the courſe of his experiments, which he looked upon himſelf as obliged to conceal for the good of mankind. Of this nature were ſeveral ſorts of poiſons, and a certain liquor, with which, he aſſures us, he could diſcharge all the writing of any deed upon paper and parchment, and leave nothing but the parties names, who ſigned it; and that the place, whence the writing had been diſcharged, would bear ink again as well as ever [f].

HIS merit as a writer in natural philoſophy and chemiſtry is univerſally acknowledged. Dr. *Herman Boerhaave* [g], after having declared lord *Bacon* to be the father of experimental philoſophy, aſſerts, that "Mr. *Boyle*, the ornament of his age and country, ſucceeded to the ge"nius and inquiries of the great chancellor *Verulam*. Which of Mr. *Boyle*'s writings ſhall I re"commend? All of them. To him we owe the ſecrets of fire, air, water, animals, vege"tables, foſſils; ſo that from his works may be deduced the whole ſyſtem of natural know"ledge." Dr. *Richard Bentley*, in his *fourth ſermon*, preached at the lecture founded by Mr. *Boyle*, thus expreſſes himſelf: *The mechanical or corpuſcular philoſophy, though peradventure the oldeſt as well as beſt in the world, had lain buried for many ages in contempt and oblivion, till it was happily reſtored and cultivated anew by ſome excellent wits of the preſent age. But it principally owes it's re-eſtabliſhment and luſtre to Mr.* Boyle, *that honourable perſon of ever-bleſſed memory, who hath not only ſhewn its uſefulneſs in phyſiology, above the vulgar doctrines of real qualities and ſubſtantial forms, but likewiſe its great ſerviceableneſs to religion itſelf.* Mr. *John Hughes* likewiſe obſerving [h], that Mr. *Boyle* was born the ſame year, in which lord *Bacon* died, tells us, that "he was the perſon, who ſeems to have been deſigned by nature, to ſucceed to the labours "and inquiries of that extraordinary genius juſt mentioned. By innumerable experiments, "he in a great meaſure filled up thoſe plans and out-lines of ſcience, which his predeceſſors "had ſketched out. His life was ſpent in the purſuit of nature, through a great variety of "forms and changes, and in the moſt rational as well as devout adoration of its divine au"thor." *Franceſco Redi*, in one of his *letters* publiſhed in the *fourth volume* of his works at *Florence* 1724, in 4to, expreſſes the higheſt eſteem and veneration for him, and aſſerts, that *he was the greateſt man, who ever was, and perhaps ever will be, for the diſcovery of natural cauſes.* But the juſteſt and completeſt character of him is given us by the learned and ingenious Dr. *Shaw*, in the *General Preface* to his *Abridgment of Mr.* Boyle's *Philoſophical Works*, where he tells us [i], that thoſe works *have, from their firſt appearing in public, done an honour to his country, and procured him a general eſteem in the world. The novelty, the variety, the dignity, and the uſefulneſs of the ſeveral ſubjects he treats, with the eaſy and familiar manner, wherein they are handled, recommend his performances to the whole body of mankind. Mr.* Boyle *accommodates himſelf as well to the unlearned and the novice, as to the philoſopher and the ſcholar; his whole ſcope and deſign being, with the utmoſt candor and ſimplicity, to communicate thoſe numerous and important diſcoveries, which coſt him infinite pains and application to make.* He afterwards remarks [k],

[a] *Burnet*'s Funeral Sermon, p. 30. [b] *Burnet*'s MS. papers. [c] Ibid. [d] *Burnet*'s Funeral Sermon, p. 36.
[e] Ibid. p. 37. [f] *Budgell*, p. 144, 145. [g] *Methodus diſcendi medicinam.* [h] Spectator, No. 554.
[i] P. 1. 2d edit. *London* 1738, in 4to. [k] Ibid. p. 4.

that

that Mr. *Boyle* takes up his reader at the elements or fundamental principles of things, and with exquiſite judgment conducts him through all the regions of nature, to furniſh him with objects, whereon to exerciſe his faculties; and being firſt ſolicitous to make him a general philoſopher, leaves him prepared for any further inquiry he ſhall think fit to make into the works of nature or art. That as the beſt and only ſolid foundation for philoſophy is its uſefulneſs to mankind; and the only way to gain it the reputation it deſerves, muſt be to manifeſt the great advantages, that attend the ſtudy thereof; ſo Mr. *Boyle* has been every where careful to ſhew, that nothing can be more ſerviceable and beneficial in life, than experimental philoſophy in general. "The men of wit and learning have, *continues Dr.* Shaw, "in all ages, buſied themſelves in explaining nature by words; but it is Mr. *Boyle* alone, "who has wholly laid himſelf out in ſhewing philoſophy in action. The ſingle point he "perpetually keeps in view, is, to render his reader not a talkative, or a ſpeculative, "but an actual and practical philoſopher. Himſelf ſets the example; he made all the ex- "periments he poſſibly could upon natural bodies, and communicates them with all deſirable "candour and fidelity." He then obſerves [a], that Mr. *Boyle* reſtrains not the buſineſs of experimenting to any particular branch of ſcience, but applies it, in full latitude, to all the elements, and all the bodies they mix with, or go to compoſe; and that the air, earth, fire, and water, all are ſcrutiniſed and tortured by experiments to confeſs their natures, offices, uſes, and the wiſdom and deſign of their creation. That he greatly opens and dilates the mind; gives us noble and generous thoughts of nature, and of our own abilities; manifeſts, that even deſperate things may be attempted with ſucceſs; and ſhews no quarter to the lazy, indolent temper of thoſe, who, from ſhallow notions, and a want of having ſeen the powers in natural bodies, are for diſcouraging all new and grand undertakings; and uniting the knowledge of the philoſopher with all the freedom and addreſs of the gentleman, he renders the moſt daring projects promiſing and advantageous. That he will never allow us to conſider the world as a rude heap of dull inactive matter, but convinces us, that it is a grand and noble machine, continually actuated, informed, and governed by a moſt wiſe and beneficent being, who keeps all the parts thereof in motion, and makes them act upon one another, according to certain laws. "Then bringing us acquainted with theſe laws, he enables us to "make uſe of the ſame ſtratagems and contrivances, which nature herſelf employs; which "ſurely are capable of performing the greateſt things, when rightly applied; that is, when "applied as Mr. *Boyle*, by his own example and experience, directs us. But he ſhews alſo, "that in order to make the moſt advantageous uſe of theſe powers, a general knowledge "of nature is required. Without large and comprehenſive views, without being well "verſed in mechanical arts, and the ſeveral branches of natural knowledge, ſo as to make "one aſſiſting to another, and all in their turn conſpire to the ſame end, Mr. *Boyle* en- "courages no man to be a projector [b]." He tells us [c], that Mr. *Boyle* is particularly cautious to guard his reader againſt every operation, that might any ways prove dangerous or hurtful; and to prevent his impoſing upon himſelf by any ſuperficial obſervation, any fallacious or contingent experiment, whether made in his own perſon, or delivered by others. And from an attentive peruſal of his admirable writings, Dr. *Shaw* declares, that in general no author appears to have been more inquiſitive into the foundations and evidence of the narratives he receives from others, or to have ſhewn greater ſagacity and induſtry in diſcovering their weak ſides; always frankly propoſing them, as he received them, to be confirmed or overthrown by farther ſearch and future diligence. For proof of this he appeals to the manner, wherein Mr. *Boyle* delivers himſelf upon what are or were eſteemed the moſt exceptionable things in his writings; the ſpecific virtue of the Peruvian bark, rue-leaved whitlow graſs, *ens veneris*, *oſteocolla*, the *ens primum* of balm, *Butler*'s ſtone, the ſympathetic powder, the weapon ſalve, the alkaheſt of *Paracelſus*, the *virgula divina*, the tranſmutation of metals, projection, or the philoſopher's ſtone, *&c.* and he deſires, that Mr. *Boyle* may be compared herein with the moſt approved and judicious authors, who have treated of the virtues of remedies, the ſecrets in chemiſtry, and the powers of nature. No doubt (ſays he) Mr. *Boyle* may appear to give more into the belief of ſome extraordinary things, than the vulgar, or perſons unacquainted with experimental philoſophy, and the immenſe powers and ſtrange operations of nature and art; but the queſtion is, whether he has here gone further than his evidence carried him. He relates alſo upon his own knowledge many things very aſtoniſhing and incredible to minds unprepared by philoſophy to entertain them. But he was ſo happy, as to have ſeen with his own eyes much more of the powers of nature and art, than can eaſily be imagined. And if we conſider the numerous phænomena, which in a very long ſeries of years ſpent upon natural inquiries, moſt of them ſucceſsful, muſt have been preſented him, by the proceſſes of his laboratory, the experiments of the pneumatic engine, his mechanical, optical, hydroſtatical, and other kinds of trials; the correſpondence he happily cultivated with the whole learned world, and particularly with the chemiſts of all nations; the various ſecrets he purpoſely kept to exchange for theirs; we ſhall ſee reaſon enough to perſuade us, that he might well be inabled to deliver things that ſhould ſound odd, ſtrange, and ſhocking to vulgar ears. To render the moſt innocent fluids poiſonous, without altering their colour, taſte, ſmell, or any obvious quality; utterly to eraſe the handwriting in a ſheet of paper or parchment, without at all unfitting either for ink; to make a baſe metal paſs even upon goldſmiths for gold; not to mention the more ſurpriſing and ſhocking

[a] Ibid. p. 6. [b] Ibid. p. 8. [c] Ibid. p. 9.

experiments of the like ſtamp; are things, that can hardly be thought poſſible or practicable by the vulgar; yet ſome chemical philoſophers could perform them with eaſe. But there are ſome philoſophers, and even chemiſts, who, if you ſhould tell them, that Mr. *Boyle* had a certain liquor, with which he could convert gold into ſilver; they would beg to be excuſed believing ſo ſtrange a thing. And why? Merely becauſe they never ſaw the like performed, and had tied themſelves down to a narrow ſtrait-laced philoſophy, that would not ſuffer them to look abroad into what nature and art can produce. *But if Mr* Boyle (ſays Dr. *Shaw*) *has actually done the thing; and others, men of veracity, have aſſured him, they had done it too; is he credulous for believing it? Thoſe rather were ſo, who without ſufficient evidence raſhly concluded the thing impracticable.* The ſame writer then obſerves [a], that ſince Mr. *Boyle* aſſures us, and gives us ſufficient grounds to believe, that he has rendered ſilver, gold, fixed alkalies, *&c.* volatile; converted acids into alkalies; produced light from a deſpicable dark ſubſtance; immediately reſtored fetid and corrupted water, by precipitating from it a ſubſtance not fetid; diſſolved the hardeſt bodies by innocent and potable liquors, without heat; produced cold by a mixture of warm bodies, heat by a mixture of cold ones; warmed cold liquors by ice; inſtantly froze ſpirit of wine; converted that ſpirit into water, water and fixed alkalies into earth; and performed numberleſs other ſurpriſing things, that appear as ſo many contradictions among the unſkilful; may he not, with good reaſon, ſpeak of them as feaſible, and proper to be tried by others? Or may he not, upon the ſtrength of human teſtimony, upon the relation of his friends and acquaintance, believe, that other men have done the ſame, or even greater things than theſe, though himſelf was not an eye-witneſs of them? If, after having made his liquid *phoſphorus* in *England*, he ſhould be aſſured, that another chemiſt had made a ſolid one in *Germany*; if, after having invented his air-pump, he ſhould have heard, that many unſuſpected diſcoveries were made by means of it; if having converted gold into ſilver, eye-witneſſes ſhould inform him, that ſilver has been converted into gold; or if having himſelf prepared a menſtruum almoſt as ſtrange as the alkaheſt, could he be reproached with credulity for believing, that *Paracelſus* or *Helmont* might poſſibly poſſeſs it in greater perfection; or that the other things were done by others? "This ſurely, "ſays Dr. Shaw [b], is not unphiloſophical, or irrational. Mr. *Boyle* was too wiſe to ſet any "bounds to nature; he was not forward to ſay, that every ſtrange thing muſt needs be im- "poſſible, becauſe he ſaw ſtrange things every day; though he always acknowledges, and "it was a common ſaying with him, that *thoſe, who had ſeen them, might better believe* "*them, than thoſe who had not.* He modeſtly thought, that all we have to do is, to keep "our eyes open, and expect what nature and art will, upon due application, perform. He "was well aware, that there are powerful agents in the world, whoſe laws and manner "of acting we want to be acquainted with. A man of a different caſt, or an ignorant "Indian, who had never looked abroad, and ſeen the common phænomena, would ſcarce "credit the moſt faithful and exact relation, that could poſſibly be made him, of the "properties and effects of the loadſtone, or of gunpowder, by perſons of the greateſt ve- "racity. But his ignorance alone is the cauſe of this incredulity. Propoſe the ſame "things to a man, who never heard of gun-powder or the loadſtone, but is otherwiſe "a general philoſopher, and he will readily and thankfully yield his aſſent, and ſollicit you "to ſhew him the experiments." The doctor then remarks [c], that we may certainly depend upon this, that what Mr *Boyle* delivers as an experiment or obſervation of his own, is related in the preciſe manner, wherein it appeared to him: no one ever yet denied, that he was a man of punctual veracity. And what he delivers as received from other hands, if it be any thing extraordinary, the reader will find, that he does it with a manifeſt diffidence, and in a quite different manner from that, wherein he gives us facts upon his own knowledge; and never entertains it for truth, without producing ſomething analogous or parallel, to countenance it, from his own obſervations or experience, always reſerving to himſelf the full liberty of believing no more than he ſees reaſon for. And what can a man do more than this, to avoid the imputation of credulity? On the contrary, do not thoſe, who, without evidence, and merely from common report, believe Mr. *Boyle* to have been credulous, give us a remarkable inſtance of their own credulity? Where-ever he believes more than other men, it is becauſe he had more reaſon for it than they. It is the general way indeed, when a ſtrange thing is related, either poſitively to deny it as impoſſible, or directly to entertain it as a truth. This is making ſhort work of it. But Mr. *Boyle* poſſeſſed in a great degree that noble faculty of ſuſpending his judgment, till by all the enquiries he could any way make, he received fuller information; and then the thing, he found, would determine itſelf.

DR. *Shaw* obſerves next [d], that Mr. *Boyle* is altogether taken up with the objects around us, and of which we are or may be put in poſſeſſion; though we remain ignorant of their properties, virtues, and uſes, till he calls them out, ſets them before us, and ſurprizes us with a ſight of our own ignorance of things ſo near us, ſo momentous in themſelves, and ſo neceſſary to our well-being and the true enjoyment of life. There is no profeſſion or condition of men, but may be benefited by his diſcoveries. As he had a wonderful comprehenſive genius himſelf, he has improved every part of natural knowledge, and the world is more obliged to this ſingle man, than to a thouſand vulgar philoſophers taken together. It is certain, that he laid the foundations of almoſt all the improvements, which have been made ſince his

[a] Ibid. p. 10. [b] Ibid. p. 11. [c] Ibid. p. 12. [d] Ibid. p. 13.

time, in natural philoſophy; and actually himſelf performed abundance of thoſe very things, and perhaps in a much better manner too, whereby ſeveral famous men have gained a reputation in putting them off for their own diſcoveries. A very fine collection of uſeful knowledge, publiſhed as the works of a foreign Society, bears a remarkable teſtimony to this truth. The mechanic, the merchant, the ſcholar, the gentleman, all are benefited by Mr. *Boyle*. He ſhews us trades in a new light, and makes them, what they really are, a part of natural philoſophy; and conſidering them accordingly, reveals ſome of their myſteries; all along advancing proper means to encourage, promote, and multiply the arts themſelves. The goldſmith, the lapidary, the jeweller, the refiner, the ſtone-cutter, the dyer, the glaſs-maker, artizans of all kinds, will from him receive the beſt informations, as to the working, managing, and employing to advantage their various commodities, materials, engines, and inſtruments. The huſbandman and the diver are here inſtructed in their arts; and the mineraliſt, the miner, and aſſayer, to find and ſeparate their ore to the greateſt profit; to encreaſe the quantity; to meliorate, improve, and inrich their metals; to purify and fine them, and accurately to diſtinguiſh the genuine and pure from the adulterate, baſe, and counterfeit. The architect and builder are ſhewn how to chooſe the beſt materials for their ſeveral purpoſes; the painter to make, to mix, and improve his colours; and no part of mankind is neglected by Mr. *Boyle*. But he ſhews a more particular regard to thoſe profeſſions, wherein the health of the ſpecies is nearly concerned. The phyſician, the anatomiſt, the apothecary, and the chemiſt, are moſt highly indebted to him. He has conſidered and improved the art of medicine in all its branches. We owe to him the beſt ways we have of diſtinguiſhing genuine drugs from adulterate; the diſcovery and preparation of ſeveral valuable medicines, with the manner of applying abundance to good advantage. He has ſhewn us the way, wherein ſpecifics may act; how to judge of the wholeſomneſs and unwholeſomneſs of the air, of water, and of places; and how to examine and make choice of mineral ſprings. In a word, there is ſcarce in art, or natural production known, but he makes ſome uſeful diſcovery or improvement in it.

His temper, according to Dr. *Shaw* [a], was moſt open, candid, generous, and communicative. He endeavours to make all the things he treats of plain, eaſy, and familiar. There is no deep knowledge in mathematics or algebra previouſly requiſite to underſtand him fully; no tedious ſyſtems need be read, to prepare us for reaping all the advantages of his philoſophy. He brings us at an eaſy rate acquainted with the moſt uſeful things in nature; and this all the world agrees to be the higheſt excellence in a philoſophical writer. His memory will be dear to poſterity, whilſt that of myſtical and enigmatical writers, ſuch as ſtudy to make things difficult, and envy mankind their knowledge, will meet with the diſregard and contempt they deſerve. What principally recommends him, and diſtinguiſhes him from the vulgar herds of chemiſts, naturaliſts, and philoſophers, is this humane temper, this open, candid, generous, and beneficent diſpoſition. He was at immenſe pains and charge in making his enquiries; he ſpared no time, no money, no diligence, in purſuing diſcoveries for the public advantages, without any ſordid view to increaſe his own fortune, which he happily thought ſufficient of itſelf. His beneficent and public ſpirit made the world a generous preſent of all the fruits of his labours, without the leaſt expectation of reward from them. His ſoul was as great and noble as his genius was comprehenſive, or his invention fruitful. And what ſhews him in the moſt amiable point of light, he was far above the ſelfiſh pleaſure of being admired for a genius, or raiſing a reputation by his diſcoveries. Though he wanted no capacity or abilities to have worked up a glorious ſyſtem, and erected a more pompous, oſtentatious, and perhaps a more durable ſtructure of natural and chemical philoſophy, than had ever appeared in the world before; he nobly deſpiſed this poor ſatisfaction and mean gratification, telling us plainly and expreſsly, that, notwithſtanding all he had done, all the labour, pains, and expence beſtowed in a life of natural inquiries, notwithſtanding the vaſtly numerous and important obſervations and diſcoveries he made, he ſaw nothing but the firſt dawnings of ſcience; has drawn only the rudiments of natural knowledge, and leaves it in charge to poſterity, for their own ſakes, to conſider him but as a beginner, and to purſue philoſophical enquiries in general, without ſtopping to raiſe petty ſyſtems by the way. "Here, *concludes Dr.* Shaw [b], was a noble "ſoul! This the deſirable character! A true philoſophical mind, well ſeaſoned with huma-"nity, beneficence, goodneſs! After he had led us through all the regions of nature; con-"ſidered her various productions; ſhewed us their uſes, and the manner of converting them "to our ſeveral purpoſes; convinced us, that we live in a world moſt wiſely contrived, "wherein numberleſs grand deſigns are at once carried on with unceaſing variety; and ma-"nifeſted, that all the beings, and all the bodies we know, jointly conſpire, as one whole, "in bringing about the great ends of nature; he bids us not ſtop here, but leaves us full of "aſſurance, that the further we enquire into the works of the univerſal architect, the more "beauty and harmony, the greater uſe and ſatisfaction we ſhall find among them; and this "as long as the frame of the world endures. Theſe noble, manly, and generous notions, "are what the reader will find inculcated through the philoſophical writings of Mr. *Boyle*; "whoſe principal aim and great delight it was to benefit mankind by them."

[a] Ibid. p. 14.

[b] Ibid. p. 15.

APPENDIX

TO THE

LIFE of the Honourable *Robert Boyle.*

NUMBER I.

The charter of the corporation for propagating the Goſpel in *New England* and the parts adjacent in *America*, of which Mr. *Boyle* was the firſt Governor. *Life*, p. 42.

CHARLES the ſecond by the grace of God, king of *England*, *Scotland*, *France*, and *Ireland*, defender of the faith, *&c.* To all, to whom theſe preſents ſhall come, greeting. Whereas by the ſeveral navigations, diſcoveries and ſucceſsful plantations of divers of our loving ſubjects of this our realm of *England*, the empire and dominion of us and our royal progenitors and predeceſſors, hath, by the bleſſing of Almighty God, been augmented and enlarged, as well upon the main land and continent of *America*, as upon ſeveral iſlands and promontories thereof, and the trade and commerce between *England* and thoſe colonies and plantations hath of late years been very much encreaſed, and by reaſon thereof, and of the pains and induſtry of certain *Engliſh* miniſters of the Goſpel, and others reſiding in or near our colonies and plantations in *New England*, who having attained to ſpeak the language of the heathen natives in thoſe parts, have, by their teaching and inſtructions, brought over many of them from the power of darkneſs, and the kingdom of Satan, to the knowledge of the true and only God, and to an owning and profeſſing of the proteſtant religion (whereof we have of late been more fully informed by the humble petition of divers miniſters and others our loving ſubjects now reſiding in this our kingdom of *England*.) And although a large door of hope be hereby opened to us for the glorifying of the name of Jeſus Chriſt, and the further enlargement of his church, yet unleſs ſome due and competent proviſion be made to lay a foundation for the educating, clothing, civilizing and inſtructing the poor natives; and alſo for the ſupport and maintenance of ſuch miniſters of the Goſpel, ſchoolmaſters, and other inſtruments, as have been, are, or ſhall be ſet apart and employed for the carrying on of ſo pious and Chriſtian a work, the ſame may be much retarded, and a work, ſo happily begun, diſcouraged; thoſe planters, who firſt began, and contributed largely thereunto, being of themſelves unable to bear the whole charge thereof. And whereas we are reſolved, not only to ſeek the outward welfare and proſperity of thoſe colonies by putting an induſtrious people into a way of trade and commerce, that they may be employed and improved, for their own and the common benefit of theſe our kingdoms, but more eſpecially to endeavour the good and ſalvation of their immortal ſouls, and the publiſhing the moſt glorious Goſpel of Chriſt amongſt them; and to the end that ſuch our loving ſubjects, as either have already been aiding herein, or as ſhall hereafter be willing to contribute hereunto, may not be diſcouraged in their intended charity, for want of ſufficient authority and patronage from us faithfully to order and diſpoſe all and every ſum and ſums of money, goods, chattels, lands, tenements, or hereditaments, that have been, or ſhall, or may be given for the purpoſes aforeſaid; know ye, that we, of our princely piety, and for the further propagation of the Goſpel of Jeſus Chriſt, amongſt the heathen natives in or near *New-England* and the parts adjacent in *America*; and for the better civiliſing, educating and inſtructing of the ſaid heathen natives in learning, and in the knowledge of the true and only God, and in the proteſtant religion, already owned and publicly profeſſed by divers of them; and for the better encouragement of ſuch others of them as ſhall imbrace the ſame, and of them and their poſterity after them, to abide and continue in, and hold faſt the ſaid profeſſion; of our eſpecial grace, certain knowledge, and mere motion, and for divers other good and pious cauſes and conſiderations us thereunto eſpecially moving, do, for us, our heirs and ſucceſſors, will, ordain, conſtitute and declare, by theſe preſents, that there be, and for ever hereafter ſhall be, within this our kingdom of *England*, a ſociety, or company, for propagation of the Goſpel in *New-England*, and the parts adjacent in *America*. And further, we do, for us, our heirs, and ſucceſſors, will, ordain, conſtitute, and appoint, that our right truſty and right well beloved couſin and counſellor, *Edward*, earl of *Clarendon*, lord

lord chancellor of *England*, our right truſty and right well beloved couſin and counſellor, *Thomas*, earl of *Southampton*, lord high treaſurer of *England*, our right truſty and well beloved counſellor, *John*, lord *Roberts*, lord privy ſeal, our right truſty and right well beloved couſin and counſellor, *George*, duke of *Albemarle*, our right truſty and right well beloved couſin and counſellor, *James*, duke of *Ormonde*, our right truſty and right well beloved couſin and counſellor, *Edward*, earl of *Manchester*, lord chamberlain of our houſhold, our right truſty and right well beloved couſin and counſellor, *Arthur*, earl of *Angleſey*, our right truſty and well beloved counſellor, *William*, viſcount *Say* and *Seale*, our well beloved *Francis Warner*, alderman of *London*, *Eraſmus Smith*, Eſq; *Henry Aſhurſt*, *Richard Hutchinſon*, *Joſhua Woolnough*, *George Clarke*, *Thomas Speed*, *Thomas Bell*, *John Rolfe*, citizens of *London*, our truſty and well beloved *Robert Boyle*, Eſq; Sir *William Thompſon*, Sir *William Bateman*, Sir *Anthony Bateman*, Sir *Theophilus Biddolph*, Sir *Lawrence Bromfield*, knights, *Tempeſt Milner*, *William Love*, *William Peake*, aldermen of *London*, *Thomas Foley*, Eſq; *Thomas Cox*, *John Micklethwait*, *Edmund Trench*, doctors in phyſick, and our well beloved *Charles Doyley*, *Thomas Staynes*, *John Jurian*, *William Antrobus*, *John Bathurſt*, *Harman Sheafe*, *Thomas Gillibrand*, *James Hayes*, *John Benbowe*, *Lawrence Brinſley*, *Barnabas Meares*, *John Acrod*, *John Dockett*, *Edward Boſcowen*, and *Martin Noell*, citizens of *London*, to be the firſt members and perſons, whereof the ſaid company ſhall conſiſt. And that they, the ſaid *Edward*, earl of *Clarendon*, *Thomas*, earl of *Southampton*, *John*, lord *Roberts*, *George*, duke of *Albemarle*, *James*, duke of *Ormonde*, *Edward*, earl of *Manchester*, *Arthur*, earl of *Angleſey*, *William*, viſcount *Say* and *Seale*, *Francis Warner*, *Eraſmus Smith*, *Henry Aſhurſt*, *Richard Hutchinſon*, *Joſhua Woolnough*, *George Clarke*, *Thomas Speed*, *Thomas Bell*, *John Rolfe*, *Robert Boyle*, Sir *William Thompſon*, Sir *William Bateman*, Sir *Anthony Bateman*, Sir *Theophilus Biddolph*, Sir *Lawrence Bromfield*, *Tempeſt Milner*, *William Love*, *William Peake*, *Thomas Foley*, *Thomas Cox*, *John Micklethwait*, *Edmund Trench*, *Charles Doyley*, *Thomas Staynes*, *John Jurian*, *William Antrobus*, *John Bathurſt*, *Harman Sheafe*, *Thomas Gillibrand*, *James Hayes*, *John Benbowe*, *Lawrence Brinſley*, *Barnabas Meares*, *John Acrod*, *John Dockett*, *Edward Boſcowen*, and *Martin Noell*, and their ſucceſſors, to be hereafter choſen into the ſaid company, and in ſuch manner, as is hereafter in theſe preſents directed, for ever hereafter be, and ſhall be, by virtue of theſe preſents, one body corporate and politic, in deed and in name, and ſhall have continuance for ever, by the name of the company for propagation of the Goſpel in *New-England* and the parts adjacent in *America*. And them the ſaid *Edward*, earl of *Clarendon*, *Thomas*, earl of *Southampton*, *John*, lord *Roberts*, *George*, duke of *Albemarle*, *James*, duke of *Ormonde*, *Edward*, earl of *Manchester*, *Arthur*, earl of *Angleſey*, *William*, viſcount *Say* and *Seale*, *Francis Warner*, *Eraſmus Smith*, *Henry Aſhurſt*, *Richard Hutchenſon*, *Joſhua Woolnough*, *George Clarke*, *Thomas Speed*, *Thomas Bell*, *John Rolfe*, *Robert Boyle*, Sir *William Thompſon*, Sir *William Bateman*, Sir *Anthony Bateman*, Sir *Theophilus Biddolph*, Sir *Lawrence Bromfield*, *Tempeſt Milner*, *William Love*, *William Peake*, *Thomas Foley*, *Thomas Cox*, *John Micklethwait*, *Edmund Trench*, *Charles Doyley*, *Thomas Staynes*, *John Jurian*, *William Antrobus*, *John Bathurſt*, *Harman Sheafe*, *Thomas Gillibrand*, *James Hayes*, *John Benbowe*, *Lawrence Brinſley*, *Barnabas Meares*, *John Acrod*, *John Dockett*, *Edward Boſcowen*, and *Martin Noell*, and their ſucceſſors, by the name of the company for propagation of the Goſpel in *New-England*, and the parts adjacent in *America*, we do, for us, our heirs and ſucceſſors, fully and really create, erect, make, ordain, eſtabliſh, conſtitute, and appoint, to be one body corporate and politic, to have continuance for ever to them and their ſucceſſors. And that by the ſame name they, and their ſucceſſors, ſhall and may have perpetual ſucceſſion, and from time to time (as occaſion ſhall require) aſſemble, and meet together, in ſome convenient place, within the city of *London*, for the ends aforeſaid. And that they and their ſucceſſors, by the name of the company for propagation of the Goſpel in *New-England*, and the parts adjacent in *America*, be forever hereafter perſons able and capable in the law to purchaſe, take, have, hold, receive, and enjoy any manors, lands, tenements, liberties, privileges, juriſdictions and hereditaments whatſoever, of what kind, quality, or nature ſoever they be, ſituate and being either within our kingdom of *England*, or elſewhere, within any other of our dominions and territories, to them, and their ſucceſſors, in fee and perpetuity, or for term of life, or lives, or years, or otherwiſe, in what ſort ſoever; ſo as the ſame exceed not, in lands and hereditaments of inheritance, the clear yearly value of two thouſand pounds; the ſtatute for not putting of lands or tenements in mortmain, or any thing therein contained, or any other act, or ſtatute, to the contrary, notwithſtanding. And alſo all manner of goods and chattels, ſum and ſums of money, and other things whatſoever, of what nature, or quality, ſoever they be. And alſo to give and grant, demiſe, let, aſſign, alien and diſpoſe of all or any of the ſaid manors, lands, tenements, or hereditaments, goods or chattels. And alſo to do, perform, and execute, all and every other lawful act and acts, thing and things, whatſoever, by the name of the company for propagation of the Goſpel in *New-England*, and the parts adjacent in *America*. And further, that the ſaid company, and their ſucceſſors, by the name aforeſaid, ſhall and may be perſons able and capable, in the law, to plead, and to be impleaded, to anſwer, and to be anſwered unto, to defend, and to be defended, in what court, or courts, ſoever, and before any judges, or juſtices, and other perſons and officers of us, our heirs and ſucceſſors whatſoever, in all and ſingular actions, pleas, ſuits, plaints, matters, and demands, of what kind, nature, or quality, ſoever they be, or ſhall be, in the ſame, and in the like, and in as ample manner and form, as any other the people of this our king-

dom of *England*, or any other body, corporate or politic, within the ſame our kingdom, may or can have, hold, take, purchaſe, poſſeſs, enjoy, retain, give, grant, demiſe, let, alien, diſpoſe, aſſign, plead, and be impleaded, anſwer, and be anſwered unto, defend, or be defended, do, perform, or execute. And that they the ſaid company for propagating of the Goſpel in *New-England* and the parts adjacent in *America*, and their ſucceſſors, ſhall and may for ever hereafter have a common ſeal, to ſerve and uſe, for all cauſes, matters, things, and affairs, whatſoever, of them and their ſucceſſors. And that it ſhall and may be lawful to and for any thirteen, or more of them, whereof the governor of the ſaid company, for the time being, to be one, to appoint, alter, and make new the ſaid ſeal, from time to time, at their wills and pleaſures, as they ſhall think fit. And further, we will and ordain, and by theſe preſents, for us, our heirs and ſucceſſors, do declare and appoint, that there be, for the better ordering and managing of the affairs and buſineſs of the ſaid company, and their ſucceſſors, and for ever ſhall be, one of the members of the ſaid company, and their ſucceſſors, who ſhall be, and ſhall be called the governor of the ſaid company; and to hold the ſaid office and place of governor of the ſaid company and their ſucceſſors, ſo long as he the ſaid governor ſhall well demean himſelf in the ſaid office and place, and that the ſaid governor ſhall have hereby power, from time to time, to ſummon, or cauſe to be ſummoned, any courts, or meetings, of the ſaid company, as often as occaſion ſhall require. And we do, for us, our heirs and ſucceſſors, aſſign, name, conſtitute, and appoint the aforeſaid *Robert Boyle*, to be the firſt and preſent governor of the ſaid company and their ſucceſſors, to hold and exerciſe the ſaid office, for ſo long time as he the ſaid *Robert Boyle* ſhall well behave himſelf therein. And therefore we will, and by theſe preſents, for us, our heirs and ſucceſſors, do give and grant unto the ſaid company for propagation of the Goſpel in *New-England* and the parts adjacent in *America*, and their ſucceſſors, that upon the death or removal of the ſaid governor, for the time being (whom for evil government, frequent neglect of attendance, or any other juſt and reaſonable cauſe, we will, and by theſe preſents do, for us, our heirs and ſucceſſors, declare, ſhall, and may, from time to time, be removed by the ſaid company, or any thirteen of them) it ſhall and may be lawful to and for the ſaid company, or any thirteen of them, as aforeſaid, at their wills and pleaſures, to elect and chuſe any other members of the ſaid company, for the time being, into the place of ſuch governor, as ſhall be dead, or removed, as aforeſaid, to hold and exerciſe the ſaid office, or place, whereunto he ſhall be ſo elected and choſen, as aforeſaid, for ſo long time as he ſhall and do reſpectively well demean himſelf therein. And alſo, in caſe of the abſence of the governor, for the time being, whereby either the meeting of the ſaid company cannot well be ſummoned, or held, or, being ſummoned, cannot proceed, or act, therein; that then the treaſurer of the ſaid company, for the time being, to be choſen, as hereafter is expreſſed, ſhall, and hath hereby power and authority to ſummon ſuch meetings; and then any five or more of the ſaid company, ſo meeting together, ſhall and may have power to appoint one of the ſaid members, ſo meeting, to ſupply the place and office of the governor, for the preſent. And to the end alſo the ſaid company may have a continual ſucceſſion, and may be the better ſupplied, from time to time, hereafter, with fit and able perſons to be members of the ſaid company, in the place and places of ſuch of the preſent members of the ſaid company herein above named, or any others that ſhall hereafter be choſen to be members of the ſaid company, and ſhall hereafter happen to die, or, as ſhall, by reaſon of their own affairs, or otherwiſe, deſire to be diſcharged, or otherwiſe ſhall be removed from being any longer members of the ſaid company, we do likewiſe, for us, our heirs and ſucceſſors, by theſe preſents, give and grant unto the ſaid company for propogation of the Goſpel in *New-England* and the parts adjacent in *America*, and their ſucceſſors, that it ſhall and may be lawful to and for the ſaid governor, for the time being, and company, and their ſucceſſors, or any thirteen, or more of them, whereof the governor, for the time being, to be one, to diſcharge or remove any ſuch perſon, or perſons, from being any longer member, or members, of the ſaid company, as aforeſaid; and by like order, at their wills, and pleaſures, to admit into the ſaid company, in the place of any of the ſaid member, or members, that ſhall be dead, or removed, as aforeſaid, any other, or ſo many, fit and diſcreet perſon, and perſons, as they ſhall ſee cauſe; ſo as the number of the ſaid perſon, and perſons, to be at any time hereafter newly admitted, and to be members of the ſaid company, together with the then remaining members of the ſaid company, for the time being, do not in the whole exceed the number of five and forty perſons. And further, we will and ordain, and, by theſe preſents, for us, our heirs and ſucceſſors, do give and grant unto the ſaid company for propagating of the Goſpel in *New-England* and the parts adjacent in *America*, and their ſucceſſors, that they, or any thirteen, or more of them (whereof the governor of the ſaid company, for the time being, to be one) ſhall and may elect and chuſe one, or more, fit and able perſon, and perſons, member, or members, of the ſaid company, to be treaſurer, or treaſurers, of the ſaid company, for the time being; and one fit perſon to be clerk of the ſaid company, to write and ſerve for the affairs of the ſaid company and their ſucceſſors; and all and every ſuch other fit perſon, and perſons, and officers, as they ſhall find meet and neceſſary, to be ſerviceable and uſeful to them, in ſuch matters and affairs, touching and concerning the ſaid company and their ſucceſſors, as he, or they, ſhall be employed in, and as they ſhall ſee cauſe, to allow them ſuch ſalaries and allowances, in execution of the ſaid re-

ſpective places, as they ſhall think meet. And the ſaid treaſurer, and treaſurers, clerk, and all other officers, as aforeſaid, to be ſo choſen by them, for reaſonable and juſt cauſe, to diſplace and remove out of their place, or places, and other meet perſons, in their or any of their places, at the pleaſure and diſcretion of the ſaid company, and their ſucceſſors, or any nine, or more of them, ſo met and aſſembled, to chuſe and elect. And we do likewiſe, for us, our heirs and ſucceſſors, by theſe preſents, further give and grant unto the ſaid company, and their ſucceſſors, that the ſaid company, and their ſucceſſors, or any nine, or more of them (whereof the governor of the ſaid company, for the time being, to be always one) ſhall and may have full power and authority, by virtue of theſe preſents, to make, ordain, conſtitute, appoint, and ſet down, from time to time, ſuch reaſonable acts, orders, inſtructions, and conſtitutions, in writing, as to them, or any nine, or more of them (whereof the governor of the ſaid company, for the time being, to be always one) ſhall ſeem fit, good, wholeſom, profitable, honeſt, neceſſary and convenient, according to their ſound diſcretions, for the ſupport of the ſaid company and their ſucceſſors; and for directing how and in what manner the ſaid governor, treaſurer, and treaſurers, clerk, and other officers and perſons, for the time being, truſted, and to be truſted and employed by the ſaid company and their ſucceſſors, ſhall and ought to demean, bear, and carry themſelves in their offices, places, and truſts, reſpectively; and for and concerning the managing, ordering, and diſpoſing of all and every the manors, lands, leaſes, tenements, hereditaments, goods, chattels, money, or ſtock of the ſaid company and their ſucceſſors, and for and concerning all and every other matters and things, incident unto, or that ſhall, or may concern the ſame, or any other the matters, or affairs, of the ſaid company and their ſucceſſors; and the ſame acts, orders, inſtructions, and conſtitutions, ſo made, and to be made, to revoke, alter, or change, and others, or new ones, to agree, make, ordain, conſtitute, appoint, and ſet down, in writing, as aforeſaid, as they or any nine, or more of them, as aforeſaid, ſhall ſee cauſe; ſo as the ſaid acts, orders, inſtructions, and conſtitutions, or any of them, be not repugnant or contrary to the laws and ſtatutes of *England*, but thereunto conformable and agreeable. Nevertheleſs, our intent and meaning is, that the governor of the ſaid company, for the time being, with any five or more of the other members of the ſame, ſhall have power, from time to time, upon all emergent occaſions, to allow of all incident charges, for and touching the meetings of the ſaid company, and other neceſſary expences, for the better managing of the affairs of the ſaid company. And to the end, that the yearly revenues, iſſues, and profits of all and every the manors, lands, leaſes, tenements, and hereditaments, and alſo the goods, chattels, money, and ſtock, of the ſaid company, and their ſucceſſors, may, from time to time, be faithfully laid out, diſpoſed, employed, and applied, for the promoting and propagating of the Goſpel of Chriſt unto and amongſt the heathen natives, in or near *New-England* and parts adjacent in *America*; and alſo for civilizing, teaching and inſtructing the ſaid heathen natives, and their children, not only in the principles and knowledge of the true religion, and in morality, and the knowledge of the *Engliſh* tongue, and in other liberal arts and ſciences; but, for the educating and placing of them, or their children, in ſome trade, myſtery, or lawful calling, we do ordain, and for us, our heirs and ſucceſſors, do, by theſe preſents, give and grant full power and authority to the ſaid governor, or any thirteen or more of the ſaid company, for the time being, under the common ſeal of the ſaid company and their ſucceſſors, from time to time, to nominate, conſtitute, and appoint, ſuch and ſo many fit and meet perſon, and perſons, reſiding in or near any of the colonies or plantations in *New-England*, aforeſaid, and parts adjacent in *America*, to be commiſſioners for and on the behalf of the ſaid company and their ſucceſſors, to treat, contract, and agree with ſuch miniſters, ſchoolmaſters, and others, reſiding, and to reſide in any the parts aforeſaid, for ſuch ſalaries, allowances, and recompences, to be from time to time made, given, and paid, to them, and every of them, for their labour, pains, and induſtry, to be taken by them and every of them, in the duties and employments aforeſaid. And alſo to treat, contract, and agree with any other perſon, or perſons, there, for clothes, books, tools, implements, and other neceſſaries, for the civilizing, employing, educating, or placing out any of the ſaid natives, or their children, that ſhall own and profeſs the proteſtant religion, in Engliſh families, or with and under Engliſh maſters there, or otherwiſe, in ſuch manner, as they, the ſaid commiſſioners, in their good diſcretions, ſhall, from time to time, think fit, and to content, pay, and ſatisfy all ſuch contracts, bargains, and agreements, and all ſalaries, wages, and allowances, to ſuch miniſters, ſchoolmaſters, and officers, as they ſhall ſo contract and agree with and for the clothing and apparelling of any of the ſaid natives, or their children, and for books, tools, implements, and other neceſſaries, for them, and for educating or placing them, or any of them, with, or under, any Engliſh maſter, or maſters, there, in any trade, myſtery, or lawful calling, out of ſuch monies, goods, and chattels, as ſhall be, from time to time, ſent, or made over, unto the ſaid commiſſioners, ſo to be appointed, as aforeſaid, or any of them, out of *England*, or any other the dominions of us, our heirs and ſucceſſors, by the ſaid company and their ſucceſſors, unto *New-England* aforeſaid, or any the parts adjacent in *America*, as aforeſaid; and alſo to do, perform and execute, all and every other act and acts, matters and things, which ſhall, or may, any way tend or conduce to the ends aforeſaid, in ſuch manner, and according to ſuch orders and inſtructions, as the ſaid commiſſioners, ſo to be employed and intruſted, ſhall, from time to time, receive

from the ſaid governor, or any other nine, or more, of the ſaid company, for the time being; which commiſſioners, ſo to be appointed, ſhall, from time to time, give an account, in writing, of their proceedings herein, ſo often as they ſhall be thereunto required, by the ſaid governor, or any other nine of the ſaid company. And that a ſupply of foreign coin, or monies, according to the abilities of the ſaid company and their ſucceſſors, may not be wanting, to be employed for and towards the ends and purpoſes aforeſaid, we do, by theſe preſents, for us, our heirs and ſucceſſors, give and grant free licence, and full power and authority to the ſaid company for propagating of the Goſpel in *New-England* and the parts adjacent in *America*, and their ſucceſſors, by direction, from time to time, of the governor, and any five, or more, of the ſaid company, for the time being, to ſhip and carry, or cauſe to be ſhipped and carried, in any Engliſh ſhip, or veſſel, within any the ports of this our kingdom of *England*, any quantity, or quantities, of Spaniſh, or other foreign ſilver coin, not exceeding in the whole, in any one year, the value of one thouſand pounds, without any charge, or cuſtom, for the ſame, ſo as, before ſuch ſhipping, the ſame, or any part thereof, to be ſo carried, as aforeſaid, the quantity and quantities, and the value and values, of the ſaid foreign coin, ſo to be ſhipped and carried, be firſt duly entered in the cuſtom-houſe of us, our heirs and ſucceſſors, of ſuch our port, or ports, of this our kingdom of *England*, where the ſaid foreign coin ſhall be ſo ſhipped, to be carried to *New-England* and parts adjacent in *America*, for any the ends, or purpoſes, abovementioned; any law, ſtatute, act, ordinance, proviſion, proclamation, or reſtraint, to the contrary, in any wiſe, notwithſtanding. And to the end, that what the ſaid company ſhall be ſeized, intereſted, or poſſeſſed of, may, from time to time, be faithfully improved, applied, and diſpoſed, for the ends, intents, and purpoſes herein before declared, and for the neceſſary affairs and buſineſs of the ſaid company and their ſucceſſors only, and no other, we will, and, by theſe preſents, for us, our heirs and ſucceſſors, do, require and ordain, that the ſaid company and their ſucceſſors do yearly, and every year (if they ſhall be thereunto required) by and upon the order and warrant of the chancellor, or keeper of the great ſeal of *England* of us, our heirs and ſucceſſors, and of the treaſurer of *England* of us, our heirs and ſucceſſors, and of the chief baron of the court of exchequer of us, our heirs and ſucceſſors, at *Weſtminſter*, for the time being, or any two of them, make, deliver, and declare, a true and perfect account, before the ſaid chancellor or keeper of the great ſeal, treaſurer and chief baron, for the time being, as aforeſaid, or any two of them, of all and every the goods, chattels, and ſtock of the ſaid company and their ſucceſſors, and alſo of the rents, iſſues and profits of all and every the manors, lands, leaſes, tenements and hereditaments, and alſo of all and every ſum and ſums of money, received, iſſued and paid, by or for the uſe of the ſaid company and their ſucceſſors; which ſaid account and accounts, as alſo the account of all and every perſon and perſons heretofore employed for the receiving or diſpoſing any rents, profits, or ſums of money, limited or appointed for propagating the Goſpel in *New-England*; we do, for us, our heirs and ſucceſſors, authoriſe and require the ſaid chancellor, or lord keeper, treaſurer, and chief baron, for the time being, or any two of them, to hear, determine, and declare; and, if they ſhall find juſt cauſe, fully to ratify, confirm, and allow of, all and every the receipts, payments, and diſburſements, in every ſuch account and accounts, to be continued, made, and applied to or for the uſes, intents and purpoſes aforeſaid; and after ſuch declaration and allowance of every ſuch account and accounts, to ſign the ſame, under their or any two of their hands, and to deliver, or cauſe to be delivered, the ſaid account and accounts, ſo to be declared, determined, and allowed of, unto the remembrancer of us, our heirs and ſucceſſors, of the ſaid exchequer, for the time being, to remain on record, in the cuſtody of the ſaid remembrancer, for our uſe and information in the premiſes, without any fee or reward, to be given, or paid, by the ſaid company and their ſucceſſors to the ſaid remembrancer, or any other perſon, or perſons, for the receiving and ſafe keeping of the ſaid account and accounts, or any of them, or otherwiſe than for the entry and writing thereof. And laſtly, we will, and, by theſe preſents, for us, our heirs and ſucceſſors, do grant unto the ſaid company for propagating the Goſpel in *New-England* and the parts adjacent in *America*, and their ſucceſſors, that theſe our letters patents, or the inrollment, or exemplification of the ſame, and all and every the matters, and things, powers, licences, and authorities, in the ſame contained, ſhall be, from time to time, good, valid, ſufficient, and effectual in the law, in and by all things, according to the true intent and meaning thereof; and ſhall be conſtrued, adjudged and taken, as well in all our courts within *England*, or elſewhere, moſt beneficially and largely, and for the benefit and advantage of the ſaid company and their ſucceſſors, any law, ſtatute, act, ordinance, proviſion, proclamation, or reſtraint, to the contrary heretofore had, made, ordained, provided, or publiſhed, or any other matter or thing whatſoever to the contrary in any wiſe notwithſtanding. In witneſs whereof we have cauſed theſe our letters to be made patent; witneſs ourſelf, at *Weſtminſter*, the ſeventh day of February, in the fourteenth year of our reign.

By writ of privy ſeal.

HOWARD.

NUM-

NUMBER II.

An exact copy of the laſt will and teſtament of the honourable *Robert Boyle*. *Life*, p. 84.

IN the name of God, Amen. I *Robert Boyle*, of *Stalbridge*, in the county of *Dorſet*, eſq; youngeſt ſon of the late right honourable *Richard*, earl of *Corke*, deceaſed, being, God be praiſed, of good and perfect memory, and taking into due and ſerious conſideration the certainty of death, and the uncertainty both of the time and manner of it; being likewiſe deſirous, when I come to die, to have nothing to do but to die Chriſtianly, without being hindred by any avoidable diſtractions from employing the laſt hours of my life in ſending up my deſires and meditations before me to heaven, do, this eighteenth day of July in the third year of the reign of our ſovereign lord and lady *William* and *Mary*, by the grace of God King and Queen of *England*, *Scotland*, *France*, and *Ireland*, defenders of the faith, *&c.* and in the year of our Lord God one thouſand ſix hundred ninety and one, make and ordain this my laſt will and teſtament in writing, in manner and form following.

FIRST and chiefly, I commend my ſoul to Almighty God, my Creator, with full confidence of the pardon of all my ſins in and through the merits and mediation of my alone Saviour Jeſus Chriſt; and my body I commit to the earth, to be decently buried within the cities of *London* or *Weſtminſter*, in caſe I die in *England*, without eſcutcheons, or unneceſſary pomp, and without any ſuperfluous ceremonies, and without the expence of above two hundred and fifty pounds, and alſo without being unneceſſarily diſſected or diſembowelled; and if it ſhall appear neceſſary, that my body be opened, then my will is, that it be performed very privately, and in the preſence of none but the phyſician, or chirurgeon, and his attendants, and of my domeſtics, or very near relations.

AND as touching my temporal eſtate, wherewith God of his goodneſs hath been pleaſed to endow me, I diſpoſe thereof in manner and form following; that is to ſay;

I GIVE and bequeath unto my dear ſiſter, the lady *Catharine*, viſcounteſs *Ranelagh*, a ſmall ring, uſually worn by me on my left hand, having in it two ſmall diamonds, with an emerald in the middle; which ring being held by me, ever ſince my youth, in great eſteem, and worn for many years for a particular reaſon, not unknown to my ſaid ſiſter, the lady *Ranelagh*, I do earneſtly beſeech her, my ſaid ſiſter, to wear it in remembrance of a brother, that truly honoured, and moſt dearly loved her.

ITEM, I give to the ſaid lady *Ranelagh* all my manuſcripts and collections of receipts, whether of my own hand-writing, or others, unleſs I do otherwiſe diſpoſe of all or any of them before my deceaſe; beſeeching her to have a care, that they or any of them come not to the hands or peruſal of any, to whom ſhe thinks, that if I were alive, I ſhould be unwilling to have them communicated. And I do likewiſe deviſe unto her the ſum of 300 *l.* (and all intereſt,) which I formerly lent her upon enlarging the dwelling-houſe in the *Pall-Mall*, which ſhe now lives in.

ITEM, whereas by my deceaſe the greateſt part of my intailed lands in *Ireland* will come to my dear and eldeſt brother, *Richard*, now earl of *Burlington* and *Corke*, I do hereby give and bequeath unto him a Sardonyx ſeal ring, which I uſually wear on my little finger, beſeeching him to accept of it, and wear it for my ſake, as a teſtimony of my unfeigned affection, and of my ſenſe of his great kindneſs and many favours towards me; and beg of him to believe, that it doth not afflict me, that I have not children of my own to inherit my intailed lands, ſince they are, by that defect, to return to him, the truly honourable head of our houſe and family.

ITEM, I give and bequeath unto my dear brother, the lord viſcount *Shannon*, the beſt watch I ſhall die poſſeſſed of, to put him in mind of my conſtant kindneſs and affection, which I endeavoured to expreſs by my voluntary yearly expence in keeping up the manor houſe of *Stalbridge*, without intending to live in it, for his ſake.

ITEM, I give and deviſe unto my worthy friend *Richard Newman* of *Weſtminſter* in the county of *Middleſex*, Eſq; a piece of plate of the value of 10 *l.* ſterling, as a teſtimony of my remembrance of his kindneſs, which I deſire him to continue by affording his aſſiſtance, if there be occaſion, to my executors hereafter named.

ITEM, I give and bequeath unto my faithful friend *John Nicholls*, Gent. ſteward of the courts of my manor of *Stalbridge*, a piece of plate of the value of 10 *l.* ſterling, to be within the ſpace of one year next after my deceaſe delivered unto him by my executors, as a teſtimony of my remembrance and affection; hereby making him the ſame earneſt requeſt, that I have hereby made to Mr. *Richard Newman*.

ITEM, I give and deviſe unto the right reverend father in God *Gilbert*, lord biſhop of *Saliſbury*, my great Hebrew bible with ſilver claſps, as a ſmall token of my great reſpect for him, and ſenſe of his favours to me.

ITEM,

ITEM, I give and deviſe unto *Thomas Smith*, now my ſervant, thirty pounds, in caſe he be with me, or in my ſervice, at the time of my death; but in caſe of his departure, or removal from me, before that time, then my will is, that he ſhall have twenty pounds, and no more.

ITEM, whereas my ſervant *John Warr* the younger is indebted unto me in the ſum of 50 *l.* by bond or bill obligatory, my will is, that his ſaid debt be remitted and diſcharged.

ITEM, whereas I had ſet apart, among other things, the ſum of 400 *l.* for certain pious uſes; and whereas his late Majeſty King *Charles* the ſecond having, by his ſpecial grace and favour, without my ſeeking, or knowledge, been pleaſed to conſtitute me governor of the corporation for propagating of the Goſpel amongſt the heathen natives of *New-England* and other parts of *America*, hath thereby given me opportunity to diſcern that work to be unqueſtionably pious and charitable; and whereas I have given and paid the ſum of three hundred pounds towards that piety; I do hereby give and deviſe the ſum of one hundred pounds more to the ſaid corporation (though by reaſon of ſickneſs and infirmity I have reſigned the office of governor) to be ſet aſide and employed as a ſtock for the relief of poor Indian converts, which I hope will prove of good effect for the advancement of the pious work, for which they are conſtituted, and in which I heartily pray him, whoſe glory the work itſelf tends unto (and I hope the perſons intruſted with it aim at) to give them a proſperous ſucceſs.

ITEM, to the Royal and learned Society for the advancement of experimental knowledge, wont to meet at *Greſham* college, I give and bequeath all my raw and unprepared minerals, as ores, marchaſites, earths, ſtones (excepting jewels) *&c.* to be kept amongſt their collections of the like kind, as a teſtimony of my great reſpect for the illuſtrious Society and deſign, wiſhing them alſo a moſt happy ſucceſs in their laudable attempts to diſcover the true nature of the works of God, and praying, that they and all other ſearchers into phyſical truths may cordially refer their attainments to the glory of the Author of Nature, and the benefit of mankind.

ITEM, to my worthy friend and phyſician, Sir *Edmund King*, Knt. I give and bequeath a ſilver ſtandiſh of the value of 30 *l.* ſterl. as an unfeigned, though ſlight teſtimony of the juſt eſteem I have of his worth and ſkill, and the ſenſe I have of his particular care of me and kindneſs for me.

ITEM, I give to Mr. *Robert Hooke*, now profeſſor of mathematics in *Greſham* college, my beſt microſcope and my beſt loadſtone, which I ſhall have at the time of my death.

ITEM, I give and bequeath unto Mr. *John Dwight* and Mr. *John Whittane*, once my ſervants, each of them a ring of 5 *l.* price.

ITEM, I give and bequeath unto Mr. *Chriſtopher White*, once my ſervant, 5 *l.* ſterl.

ITEM, I give and bequeath unto Mr. *John Milne* and Mr. *Hugh Gregg*, once my ſervants, each of them a ring of 6 *l.* price.

ITEM, I give unto *Nicholas Watts*, my bailiff of the manor of *Stalbridge*, a piece of plate of the value of 10 *l.* or 10 *l.* ſterl. in money, in lieu thereof, to be at his own choice.

ITEM, I give unto my aforeſaid ſervant *John Warr*, 40 *l.* and the one half of my wearing apparel and linen, in caſe he be with me at the time of my death; but otherwiſe to have no ſhare of my apparel or linen.

AND I give to *Robert St. Claier*, my ſervant, the ſum of 15 *l.* and the other half of my apparel and linen, in caſe he continues to be my ſervant, at the time of my death: if he doth not, then I give to him a ring of 6 *l.* price only. And to Dr. *Fredrick Slare*, late my ſervant, a ring of 8 *l.*

AND I make and ordain my ſaid dear brother, *Richard* earl of *Burlington* and *Corke*, and my ſaid dear ſiſter, the lady *Ranelagh*, and *John Warr* the younger, gent. my preſent ſervant, ſole executors of this my laſt will and teſtament.

ITEM, I give and deviſe to my ſaid executors all my eſtate, right, title and intereſt of, in, and to a certain leaſe, bearing date in or about the month of made by the corporation of mines royal, or their authority, unto *William*, lord viſcount *Brounker*, Sir *Robert Moray*, Knt. late lord *Brereton*, and myſelf, of a mine, or mines, in or near the pariſh of *Aſhbury* in *Cheſhire*, for 41 years, or thereabouts.

ITEM, whereas the executors of *James Watſon*, late alderman of the city of *Dublin*, and *Abraham Richens*, late of the ſame city, merchant, or ſome one of them ſtand indebted to me in nine hundred and ſixty pounds, or thereabouts, towards ſatisfaction whereof I have received the ſum of fourſcore pounds, or ſomewhat more, for a houſe in *Dames-ſtreet*, *Dublin*, ſold by me to my once worthy friend, Sir *John Temple*, Knt. deceaſed, formerly maſter of the rolls; which houſe was made over unto me, amongſt other things, towards ſatisfaction of the ſaid debt, upon a decree, which I obtained in the then called the court for the adminiſtration of juſtice ſitting at *Dublin* aforeſaid. And whereas the ſaid debt of 960 *l.* or thereabouts, ſaving and except the 80 *l.* or ſomewhat more, ſo as aforeſaid beforementioned to be received, is ſtill due and owing; I give and deviſe the ſame, with all writings of what kind ſoever thereunto belonging, and the proceed of compoſition for the ſaid debt, whenſoever it ſhall happen, to be made unto my executors; and I do hereby will and declare, that all and every of my bequeſts aforeſaid unto the ſaid *Richard* earl of *Burlington*, the lady *Ranelagh*, and *John Warr*, my ſervant, jointly, as executors, and in that capacity, ſhall not be for their

own private uſe, but only in truſt for and towards the payment of my debts and legacies hereby deviſed, and towards and for performance of this my laſt will and teſtament, and to and for no other uſe or uſes whatſoever.

AND as touching the diſpoſition of all and ſingular my caſtles, manors, lordſhips, meſſuages, lands, tenements, and hereditaments in the kingdom of *Ireland*, which I have power to diſpoſe of, this is the laſt will and teſtament of me the ſaid *Robert Royle* made and declared the day and year firſt above written, *viz.*

I GIVE and deviſe unto the right honourable *Richard* earl of *Burlington* and *Corke*, my dear nephew the honourable *Henry Boyle*, Eſq; of *Caſtle-Martyr* in the county of *Corke*, and Sir *Robert Southwell* of *Kingſale* in the kingdom of *Ireland*, all my eſtate, right, title, intereſt, and demand whatſoever of, in, and unto the caſtle, town, manor, and lands, being nine plow-lands and half, or thereabouts, of *Buttevant*, and the moiety of the lands called *Buttevant* and *Rices* lands in the county of *Corke*, ſeveral years ſince mortgaged to my father and unto me for the ſum of 2000 *l.* ſterling, or thereabouts, and after my father's deceaſe leaſed by me under certain covenants and conditions for thirty one years unto lieutenant colonel *Agmondeſham Muſchampe* for about the ſum of ſix ſcore pounds *per ann.* and now or lately in leaſe to *Denny Muſchampe*, Eſq; and alſo all my eſtate, right, title, intereſt, claim, and demand whatſoever, of, in, and to all and ſingular the towns, lands, tenements, and hereditaments of *Rathenege*, and four pounds chief rent iſſuing out of the lands of *Turmore* and *Ballytramly* by the name of five Caſtles, all lying in the aforeſaid county of *Corke*, and all my eſtate, right, title, intereſt, and demand whatſoever of, in, and to the impropriate rectory of *Adare* alias *Athdare* in the county of *Limerick* in *Ireland*; and alſo all my eſtate, right, title, intereſt, and demand whatſoever of, in, and to the caſtles, towns, and lands, containing two plow-lands and half (be it more or leſs) of *Ballydangan*, *Killcroyne*, and *Ballybrittas*, heretofore mortgaged to my ſaid father for the ſum of 1000 *l.* or thereabouts, to have and to hold all and ſingular the ſaid caſtles, manors, lordſhips, meſſuages, lands, hereditaments, and premiſes of *Buttevant*, *Rices* lands, *Rathenege*, and the 4 *l.* a year chief rent of impropriation of *Adare*, the two plow-lands and half of *Ballydangan*, *Killcroyne*, and *Ballybrittas*, and all other the premiſes and ſum or ſums of money therefore or thereout due and payable unto me, with all my eſtate, right, title, intereſt, claim, and demand whatſoever in and to the premiſes, and every part, member, and appurtenances of them, every or any of them; and alſo all deeds, evidences, and writings whatſoever for or concerning the premiſes or any part thereof, to them the ſaid *Richard* earl of *Burlington*, the honourable *Henry Boyle*, Eſq; and Sir *Robert Southwell*, and their heirs and aſſigns for ever, as fully and in as large and ample a manner, as the premiſes or any part thereof are or inveſted in, deſcended, come, given, deviſed or bequeathed unto me the ſaid *Robert Boyle*, upon ſpecial truſt and confidence notwithſtanding, and to and for the only uſes, intents, and purpoſes in and by this will and teſtament limited and declared, and to and for no other uſe, intent, or purpoſe whatſoever: that is to ſay, that they the ſaid *Richard* earl of *Burlington*, the honourable *Henry Boyle*, Eſq; and Sir *Robert Southwell* and their heirs, ſhall, after my death, by and with the advice of my executors, ſell the ſaid reſpective premiſes, and pay the money thereby raiſed, as alſo the profits until ſale, unto my ſaid executors, to and for the uſes herein expreſſed.

ITEM, I give unto my ſaid executors all and every ſuch ſum and ſums of money, as ſhall be raiſed out of or by ſale of my ſaid lands; and alſo all my printed books, goods, chattels, plate, monies, jewels, aad credits whatſoever, and herein before bequeathed, limited, or appointed unto them, to and for the only uſes, intents, and purpoſes hereafter alſo in and by theſe preſents limited, expreſſed, and declared, and to and for no other uſe, intent, or purpoſe, whatſoever: that is to ſay, to the intent and purpoſe, that the ſaid *Richard* earl of *Burlington*, lady *Ranelagh*, and *John Warr*, their heirs, executors, adminiſtrators, or aſſigns, ſhall with what convenient ſpeed they can, after my deceaſe, by ſale or compoſition, (though upon terms advantageous to the buyers) ſell and make money of all the ſaid caſtles, lands, mortgages, goods, and chattels, cattle, plate, jewels, and credits by this my laſt will and teſtament bequeathed unto them, or to my ſaid truſtees, *Richard* earl of *Burlington*, the honourable *Henry Boyle*, Eſq; and Sir *Robert Southwell*; and ſhall, in ſome convenient time after my deceaſe, out of the proceed of the ſaid ſale or compoſitions duly and fully ſatisfy, pay, and diſcharge as well all the ſeveral debts and ſums of money (at preſent not amounting to much) which I now do, or at the time of my deceaſe ſhall owe to any perſon or perſons whatſoever, and the charges of the funeral of my body; and alſo all ſuch legal engagements, as I have undertaken to perform to any perſon or perſons whatſoever; eſpecially to my tenants of my manor of *Stalbridge:* and from and immediately after my debts and funeral charges, and all ſuch legacies, as I have above by this my will given and bequeathed, ſhall be diſcharged and paid, and my aforeſaid engagements made good; then my will is, that the reſt, reſidue, and remainder of the proceed of the ſale of, or compoſition for all the ſaid lands, mortgages, and chattels hereby deviſed and bequeathed unto the ſaid *Richard* earl of *Burlington*, lady *Ranelagh*, and *John Warr*, my ſaid executors, ſhall be by them ſummed up: and that in the firſt place they do diſtribute among the poor (having therein a ſpecial regard unto the poor of the pariſh of *Stalbridge*, and of the pariſh of *Fermoy*, in the county of *Corke*, in the kingdom of *Ireland*, and other pariſhes in that kingdom, where any of my lands do lie) the ſum of 300 *l.* ſterl. and next after the diſtribution thereof the ſum of 200 *l.* ſterl. more

amongſt the much diſtreſſed perſons of all qualities, that have been forced or frighted out of *Ireland*, and that ſhall happen to be in or near *London*, *Briſtol*, *Cheſter*, or *Liverpool*, at the time of my deceaſe; which ſums with reſpect chiefly to ſome things, that occurred in a gracious deliverance, that was vouchſafed me in great diſtreſs, I think fit to charge my executors with the payment of after my deceaſe. And alſo in the next place, that after the diſtribution of the ſums of 300 *l.* and 200 *l.* as aforeſaid, and alſo after the payment of the ſum of 66 *l.* 4 *s.* to the abovementioned Sir *Robert Southwell*, to be diſtributed by him amongſt the incumbents, reſidents, and widows and children of ſuch as have been incumbents and reſidents in the ſeveral pariſhes, of which I have the impropriations in the kingdom of *Ireland*, and to ſuch of them, and in ſuch proportion, as the ſaid Sir *Robert Southwell* ſhall think moſt needing and deſerving of the ſame; that then they pay to my friends and kindred, named in the ſcedule to this my will annexed, the reſpective ſums therein expreſſed, in the whole amounting to the ſum of four hundred pounds; and after payment thereof I will and deviſe all the reſidue and remainder of my goods and chattels, real and perſonal, and of the money to be raiſed by the ſales aforeſaid by this my laſt will above directed to my ſaid dear ſiſter, the lady *Ranelagh*, with this deſire nevertheleſs, and my will is, that in caſe the ſaid reſiduary part of my ſaid eſtate ſhall amount (as I verily believe it will by far) to more than 800 *l.* ſterl. over and above the legacies and bequeſts above deviſed and diſpoſed of, that then my ſaid dear ſiſter do retain and enjoy, for her own uſe, the ſum of 200 *l.* ſterl. over and above the 300 *l.* debt above remitted to her (my intention being, that ſhe ſhall be benefited in the total to the value of 500 *l.* ſterl. by this my laſt will and teſtament) and this legacy being from the beforementioned reſiduary part of my eſtate, then my will is, that the overplus be laid out by my ſaid dear ſiſter, in caſe ſhe ſurvive me, and in caſe of her death, by my executors, in ſuch manner, as by my codicil or other writing under my hand I ſhall hereafter direct; and for want of ſuch direction for charitable and other pious and good uſes at her or their direction. But I do chiefly recommend unto her and them the laying of the greateſt part of the ſame for the advance or propagation of the Chriſtian religion amongſt infidels; and I hope my relations and friends will believe my intentions to be as good towards them now, as when I thought I had eſtate more conſiderable to diſpoſe of than now I have (eſpecially having of late years loſt, by the breaking of goldſmiths and others, above 1500 *l.* and ſince that, by the unfaithfulneſs of my receiver in *Ireland*, above 900 *l.* and ſince that alſo by the deſtructive inſurrections and war, that hath happened in *Ireland*, the whole income for above two years laſt paſt of my eſtate there) and will therefore accept in good part of what legacies ſhall be preſented unto them by my executors, conſidering, that it is the duty of every honeſt man to prefer doing of acts of juſtice before thoſe of kindneſs, when he is not ſure he is able to do both at once.

AND whereas divers lands and tenements, by this my will above directed to be ſold, were originally mortgaged eſtates, to the end therefore that the heirs of the mortgagers may have no juſt cauſe to complain, nor the buyers be miſtaken in their purchaſes, I do hereby declare, direct, and appoint, that in caſe my couſin , the heir of Sir *Piercy Smith*, long ſince deceaſed, ſhall deſire, within the ſpace of one year after notice given him by my executors, to redeem the impropriate rectory of *Adare*, which was mortgaged by the ſaid Sir *Piercy Smith* for 1000 *l.* and ſhall not do the ſame, that then, upon his releaſing of all his right and equity of redemption, the ſum of 66 *l.* ſhall be paid to him out of the proceed and ſale of the ſaid rectory, as a gift or legacy from me to him. But my will is, that the ſaid ſum of 66 *l.* ſhall not be paid unto him, unleſs he releaſe as aforeſaid within one year after the notice aforeſaid. And whereas the caſtle, town, and lands of *Ballydangan*, *Killcroyne*, and *Ballybrittas* aforementioned were heretofore transferred by me to my honoured couſin *Michael*, archbiſhop of *Armagh*, and primate of all *Ireland*, to have and to hold to the ſaid archbiſhop and his heirs, from and after the determination of divers years yet to come and expire: and whereas ſome years ſince, when the ſaid lands were ready to come into my hands, I made a promiſe to leaſe the ſaid premiſes to my abovenamed dear brother, the earl of *Burlington* for all my term and intereſt therein under the rent of 60 *l. per ann.* or thereabouts *de claro*, I do hereby ratify and confirm my ſaid promiſe, and do will and appoint, that he ſhall hold and enjoy the ſame under the rent of 60 *l. per ann.* during all the reſidue of my ſaid term and intereſt, which ſhall be to expire at the time of my death.

LASTLY, I do hereby earneſtly deſire my ſaid executors to ſee this my will, and my truſts in them repoſed, faithfully performed, as they hope or deſire to have their own wills faithfully performed. But for as much as by reaſon of the uncertainties of the times it may happen (which God forbid) that my eſtate may meet with ſome further misfortunes, whereby it ſhall be ſo weakened as not to be ſufficient to diſcharge all the legacies by this my will bequeathed; then my will is, that after the payment of 300 *l.* by me deviſed to the poor, and the ſum of 200 *l.* by me deviſed to the much diſtreſſed perſons of all qualities, *&c.* as aforeſaid, mentioned to be in reſpect of a deliverance from a diſtreſs (which I hereby will ſhall be obſerved) that then my other legatees ſhall each of them be reſpectively abated their legacies, in proportion to what my ſaid eſtate ſhall fall ſhort of my ſaid other legacies, above by me deviſed.

IN witneſs whereof, I the ſaid *Robert Boyle*, revoking and diſannulling all other and former wills, teſtaments, and bequeſts, have to every ſheet of this my laſt will and teſtament, contained

tained in ſeven ſheets of paper, ſet my hand, and to the laſt of them my ſeal, the day and year firſt abovewritten.

Robert Boyle.

SIGNED, ſealed, publiſhed, and declared by the abovementioned *Robert Boyle*, as his laſt will and teſtament, the day and year firſt abovewritten in the preſence of us,

Iſaac Garnier,
John Caddick,
James Oglebey,
William Johnſon.

A ſchedule in my will referred unto, for the diſpoſition of 400 *l.* which I will ſhall be paid to the perſons herein after ſet down, in ſuch proportion to each perſon, as is herein expreſſed: *viz.*

IMPRIMIS, to my honoured and dear nephews, the earl of *Barrimore*, 30 *l.* the earl of *Ranelagh*, 30 *l.* *Charles* lord *Clifford*, 30 *l.* Capt. *Robert Fitz-gerald*, 30 *l.* Capt. *Henry Boyle*, 30 *l.*

ITEM, to my honoured and dear nieces, the counteſs dowager of *Thanet*, 30 *l.* the counteſs dowager of *Clancarty*, 30 *l.* the lady viſcounteſs of *Powers-Court*, 30 *l.* the lady *Francis Shaen*, 30 *l.* the lady *Catharine Fitz-gerald*, 30 *l.* and to Mrs. *Elizabeth Melſter*, not to make a difference between her and my other nieces in my affection, no more than there is in their relation to me, but becauſe of her peculiar circumſtances, I give 100 *l.*

Robert Boyle.

THIS is the ſchedule referred to and mentioned in the fifth ſheet of this the laſt will and teſtament of the honourable Mr. *Robert Boyle*, as a part thereof, and was by his appointment annexed hereunto, and, at and before the enſealing and publiſhing this his will, ſigned by him in the preſence of us,

James Garnier,
John Caddick,
James Oglebey,
William Johnſon.

WHEREAS an act of parliament in *Ireland*, intitled, *An Act for the better Execution of his late Majeſty King Charles the ſecond's gracious Declaration of the Settlement of his Kingdom of Ireland, and Satisfaction of the ſeveral Intereſts of Adventurers and Soldiers and others the Subjects there*, it was enacted (amongſt other things) that I *Robert Boyle*, my executors, adminiſtrators, and aſſigns, ſhould and might, for and during the term of thirty one years, have, hold, and enjoy all and ſingular the impropriations of or belonging to the reſpective abbies late diſſolved, monaſteries, religious houſes, priories or pariſhes of *Ballytubber*, in the county of *Mayo*, *Knockmoy-Kireleulta Iran, alias*, St. *Mary*'s *Athenree*, and *Dunmore* in the county of *Galway*, and *Tybone* in the county of *Tipperary*, or any of them, together with all the impropriate tythes and rectories and appurtenances of the ſaid impropriations, tythes, and rectories, or belonging thereunto, which belong unto, or by that act were veſted in his late Majeſty to any of the uſes therein before mentioned, according to the tenor and effect of ſuch grant or grants, as had, or then were, or then after ſhould be paſſed unto me thereof by his late Majeſty's letters patents in that behalf, I or they paying yearly for the ſame double the exchequer or crown rent reſerved thereupon in the year 1641: now I the ſaid *Robert Boyle* do hereby give and deviſe to my dear brother *Richard* earl of *Burlington* and *Cork*, in *Ireland*, the right honourable *John* lord viſcount *Maſſerine*, *Clotworthy Skeffington*, Eſq; of the county of *Antrim* in *Ireland*, and Sir *Peter Pett*, Knt. their executors, adminiſtrators, and aſſigns, the fourth part (the whole in four parts to be divided) of the ſaid impropriations and premiſes in and by the ſaid act granted, limited, or appointed by me to be held and enjoyed during the ſaid term of one and thirty years upon truſt, to be by them employed and diſpoſed for ſuch good and pious uſes, as I ſhall from time to time declare or appoint it, or in default of ſuch appointment, after the death of me the ſaid *Robert Boyle*, then for ſuch pious and good uſes, as my ſaid truſtees in their beſt judgments and conſciences ſhall think to be moſt agreeable to my intent. And I deviſe the one moiety or half part of the other three parts of the premiſes unto the executors or aſſigns of my late dear ſiſter-in-law *Margaret*, counteſs dowager of *Orrery*, for all the reſidue of the term, that ſhall be to come at the time of my death. And as to the other moiety of the ſaid three parts, I deviſe the ſame to the right honourable *Elizabeth*, counteſs dowager of *Angleſey*, her executors and aſſigns, for all the reſidue of the term, that ſhall be to come at the time of my death; and in caſe of her dying before me, I deviſe the ſame to her executors, adminiſtrators, and aſſigns.

IN witneſs whereof I have hereunto ſet my hand and ſeal the 25th day of July, in the year of our Lord God 1691.

Robert Boyle.

SIGNED, ſealed, and publiſhed by the abovenamed *Robert Boyle*, as part of his laſt will in the preſence of us,

Iſaac Garnier,
Robert St. Claire,
William Johnſon,
James Oglebey.

MEMORANDUM, that whereas I had thoughts of diſpoſing to good uſes of what money came to my hands on the ſcore of my ſhare of the grants mentioned in the codicil, whereunto this paper is annexed, to be granted to me by his late Majeſty King *Charles* the ſecond, in the act of ſettlement of his kingdom of *Ireland:* and whereas I myſelf living in *England*, found it difficult to meet with perſons every way qualified to be employed in the laying out of ſuch money to the uſes I deſigned, by which means there remains yet undiſpoſed of the ſum of 200 *l.* which is now in the hands of the Eaſt-India company of merchants of the city of *London*, for ſecurity whereof I have their writing or bill under their common ſeal, dated the 20th day of May 1681; which ſaid writing or bill, together with the benefit, intereſt, and increaſe thereof, I have, by indenture of aſſignment aſſigned, transferred, and ſet over unto Sir *Henry Aſhurſt*, of *London*, Bart. by the name of *Henry Aſhurſt*, of *London*, Eſq; in truſt (as by the ſaid indenture dated the 9th day of January 1684, relation being thereunto had, may appear) to and for ſuch uſes, intents, and purpoſes, as I ſhould at any time afterwards direct or appoint: and I having hitherto made no direction or appointment, do hereby, in caſe I diſpoſe not otherwiſe of it, or any part of it, during my life-time, deviſe, leave, and bequeath the ſaid ſum of money, with the benefit, intereſt, and increaſe thereof, to my truſtees, *Richard* earl of *Burlington* and *Corke* in *Ireland*, the right honourable *John* lord viſcount *Maſſereen*, *Clotworthy Skeffington*, Eſq; and Sir *Peter Pett*, their executors, adminiſtrators, and aſſigns, to be by them received and diſpoſed of to the ſame uſes, for which I intruſt them with my ſhare of the impropriations of *Ballytubber*, *Knockmoy*, *&c.* mentioned in the foregoing codicil. And in caſe that within ſome reaſonable time after my deceaſe my title to the premiſes, or any of them, or to the money received by me on the ſcore of any of them, ſhall not be queſtioned, or like to be called in queſtion, to the prejudice of my executors, then my deſire is, that the truſtees may diſtribute the ſaid ſum, according as their conſciences and diſcretion ſhall direct them, among the preaching miniſters (whether parſons, rectors, vicars, or curates) that have beſtowed their pains as incumbents in the pariſhes or churches granted to me by the aforeſaid act, ſince they came into my quiet poſſeſſion, or to their poor widows or children, the ſaid truſtees being deſired to have regard in the diſtribution to the piety and orthodoxneſs of the parſons, to their pains and faithfulneſs in performing the work of their miniſtry, to the ſmalneſs of the worth of their livings, and to the conſiderableneſs of income they yield the impropriation. And by this direction I deſire and charge my ſaid truſtees to take their meaſures in diſpoſing of the future income or proceed of all that I have intruſted them with; only in caſe it ſhall appear to them for weighty reaſons, that ſomewhat may be ſpared for ſome other eminently good and pious uſe or uſes, they are left at liberty to uſe their diſcretion therein; provided the main part of the abovementioned money and future income be employed for the encouragement of pious preaching miniſters in the ſaid impropriations.

WHEREAS I have an intention to ſettle in my life-time the ſum of 50 *l. per ann.* for ever, or at leaſt for a conſiderable number of years, to be for an annual ſalary for ſome learned divine, or preaching miniſter, from time to time, to be elected and reſident within the city of *London*, or circuit of the bills of mortality, who ſhall be injoined to perform the offices following, *viz.* firſt to preach eight ſermons in the year for proving the Chriſtian religion againſt notorious Infidels, *viz.* Atheiſts, Theiſts, Pagans, Jews, and Mahometans, not deſcending lower to any controverſies, that are among Chriſtians themſelves; theſe lectures to be on the firſt monday of the reſpective months of January, February, March, April, May, September, October, November, in ſuch church, as my truſtees herein named ſhall from time to time appoint.

SECONDLY, to be aſſiſting to all companies, and encouraging of them in any undertaking for propagating the Chriſtian religion to foreign parts.

THIRDLY, to be ready to ſatisfy ſuch real ſcruples, as any may have concerning theſe matters, and to anſwer ſuch objections or difficulties, as may be ſtarted, to which good anſwers have not yet been made.

AND whereas I have not yet met with a convenient purchaſe of lands of inheritance for accompliſhing ſuch my intention, I do therefore will and ordain (in caſe it ſhall pleaſe God to take me hence before ſuch ſettlement be made) that all my meſſuage or dwelling-houſe in St. *Michael's Crooked-Lane*, *London*, which I hold by leaſe for a certain number of years yet to come, ſhall ſtand and be charged during the remainder of ſuch term as ſhall be to come and expire at the time of my deceaſe, with the payment of the clear yearly rent and profits, that

ſhall from time to time be made thereof (ground-rent, taxes, and neceſſary reparations being firſt to be deducted) to be paid to ſuch learned divine, or preaching miniſter, for the time being, by quarterly payments, that is to ſay, at Midſummer, Michaelmas, Chriſtmas, and Lady-Day, the firſt payment to begin at ſuch of the ſaid feaſts, as ſhall firſt happen next after my deceaſe, and ſhall be made to ſuch learned divine, or preaching miniſter, as ſhall be in the employment at the time of my death, during his continuance therein. And I will, that after my death Sir *John Rotheram*, ſerjeant at law, Sir *Henry Aſhurſt*, of *London*, Knt. and Bart. *Thomas Teniſon*, doctor in divinity, and *John Evelyn* ſenior, Eſq; and the ſurvivors or ſurvivor of them, and ſuch perſon or perſons as the ſurvivor of them appoint to ſucceed in the following truſt, ſhall have the election and nomination of ſuch lecturer, and alſo ſhall and may conſtitute and appoint him for any term not exceeding three years, and at the end of ſuch term ſhall make a new election and appointment of the ſame or any other learned miniſter of the Goſpel reſiding within the city of *London*, or extent of the bills of mortality, at their diſcretions. And I do hereby will and ordain this my codicil to be a part of my laſt will and teſtament. Witneſs my hand and ſeal, this 28th day of July in the year of our lord 1691.

Robert Boyle.

SIGNED, ſealed, publiſhed, and declared by the honourable *Robert Boyle*, to be a codicil to and part of his laſt will and teſtament, in preſence of us,

Iſaac Garnier,
Robert St. Claire,
James Oglebey,
William Johnſon.

WHEREAS ſince the making and executing of my laſt will and teſtament, ſeveral perſons are brought to my remembrance, whom I ſhould have made legatees in my ſaid will, had I thought upon them before my finiſhing thereof; and being unwilling, that they ſhould be wholly deprived of my intended kindneſs to them; wherefore I have thought fit to inſert their ſeveral names and legacies in this my codicil, which I hereby declare to be a part of my ſaid will.

IMPRIMIS, I give and bequeath unto my couſin Mrs. *Catharine Molſter*, daughter of my niece Mrs. *Elizabeth Molſter*, the ſum of 100 *l.* to be paid unto her, when ſhe ſhall have attained to her age of 21 years, or upon the day of her marriage, which ſhall firſt happen.

ITEM, I give and bequeath unto Sir *Robert Southwell* the ſum of twenty pounds.

ITEM, I give and bequeath unto Sir *Henry Aſhurſt*, Knt. and Bart. the ſum of twenty pounds.

ITEM, I give and bequeath unto Sir *William Aſhurſt*, Knt. and alderman of the city of *London*, the ſum of twenty pounds.

ITEM, I give and bequeath unto Sir *John Rotheram*, ſerjeant at law, the ſum of twenty pounds.

ITEM, I give and bequeath unto my ſervant *William Johnſon* the ſum of fifteen pounds.

ITEM, I give and bequeath unto ſuch a number of the French proteſtant refugees inhabiting in and about the cities of *London* and *Weſtminſter*, as my executors ſhall think fit to pitch upon, and ſhall judge to be moſt neceſſitous, the ſum of 100 *l.* to be divided amongſt them, according to the diſcretion of my ſaid executors.

AND whereas *Nicholas Courtney*, in the *Inner-Temple*, Eſq; is and hath been for ſeveral years indebted unto me in the ſum of 150 *l.* principal money, beſides intereſt for the ſame during the time he hath had the ſaid money; now in conſideration, that the ſaid *Nicholas Courtney* hath done ſome buſineſs for me in my life-time, I do hereby remit and fully diſcharge him, his executors, and adminiſtrators of and from all the intereſt money, which now is or ſhall be due unto me from him or them at the time of my deceaſe. And I do hereby declare, that this codicil ſhall be added to my laſt will and teſtament, and be a part thereof. In witneſs whereof I have hereunto ſet my hand and ſeal, the 30th day of July, in the third year of the reign of our ſovereign lord and lady, King *William* and Queen *Mary*, over *England, &c. Annoque Domini* 1691.

Robert Boyle.

SIGNED, ſealed, publiſhed, and declared by the honourable *Robert Boyle*, Eſq; as a codicil to be added to his laſt will and teſtament, and to be a part thereof, in the preſence of us,

Iſaac Garnier,
Robert St. Claire,
Jo. Caddick.

WHEREAS I have in and by my laſt will and teſtament impowered my moſt honoured and deareſt brother the right honourable *Richard* earl of *Burlington* and *Corke*, the honourable *Henry Boyle*, Eſq; and Sir *Robert Southwell*, my truſtees, to grant, bargain, ſell, and diſpoſe of to the beſt advantage, immediately after my deceaſe, all that the manor and lands of

Buttevant and *Rices* lands in the county of *Corke* within the kingdom of *Ireland*, with all and ſingular their rights, members, and appurtenances for and during ſo long time and term, as there ſhould be then to come and unexpired in the ſaid premiſes, in caſe the ſame ſhould not be redeemed; and have therein declared, that the money to be raiſed by the ſale or redemption thereof ſhould be by my ſaid truſtees paid unto my executors: and having for a long time determined to make ſome real expreſſions of the great reſpects and kindneſs, which I have for and bear to my aboveſaid brother, and to the right honourable *Charles* lord *Clifford*, (ſon and heir apparent of my ſaid brother,) my honourable nephew, by making ſome gift or preſent to the off-ſpring of my ſaid brother: now in proſecution of my ſaid determination, I do hereby publiſh and declare, that my executors ſhall make an even and equal dividend of the ſaid purchaſe or redemption money, when paid to them by my ſaid truſtees as aforeſaid, and one moiety or half part thereof, my will is, that my executors ſhall pay back unto my ſaid brother the earl of *Burlington* and *Corke*, upon ſpecial truſt and confidence, nevertheleſs, and to the uſe, intent, and purpoſe herein aftermentioned and declared; that is to ſay, that he the ſaid earl ſhall apply, lay out, pay, and employ the ſame moiety or half part of the ſaid money within three months after his receipt thereof for the uſe and beſt advantage of ſuch one or more of the younger children now unmarried of the ſaid lord *Clifford*, and in ſuch proportion, if to more than one, as to him the ſaid earl, his executors, adminiſtrators, or aſſigns, ſhall ſeem fit; and under this further truſt, that in caſe he the ſaid earl, his exetors, adminiſtrators, or aſſigns, ſhall fail to ſettle and diſpoſe of the ſame, according to the ſaid truſt, within three months after the ſame is paid to him by my executors as aforeſaid, that then he the ſaid earl, his executors, adminiſtrators, and aſſigns, ſhall ſtand poſſeſſed of the ſaid moiety or half part of the purchaſe or redemption money, ſo paid to him as aforeſaid, in truſt for all the younger children now unmarried as aforeſaid, of him the ſaid lord *Clifford*, ſhare and ſhare alike. And as for the other moiety or half part of the ſaid purchaſe or redemption money, which will remain in the hands of my executors, I do hereby publiſh and declare ſhall be employed by them to the uſe or uſes in my ſaid laſt will declared and appointed. And this codicil I do hereby declare ſhall be added to my laſt will and teſtament, and be a part thereof. In witneſs whereof I have hereunto ſet my hand and ſeal the firſt day of Auguſt in the third year of the reign of our ſovereign lord and lady King *William* and Queen *Mary* over *England*, &c. *Annoque Domini* 1691.

Robert Boyle.

SIGNED, ſealed, publiſhed and declared by the honourable *Robert Boyle*, Eſq; as a codicil to be added to and be a part of his laſt will and teſtament in the preſence of us,

Iſaac Garnier,
Robert St. Claire,
William Johnſon,
James Oglebey.

WHEREAS I have in and by my laſt will and teſtament ſettled and appointed the ſum of 200 *l.* ſterling to be paid and diſtributed by my executors to and amongſt ſuch diſtreſſed Iriſh proteſtants of all qualities, as have been either forced or affrighted out of the kingdom of *Ireland* ſince the late calamities there, and that ſhould happen to be in or near *London*, *Briſtol*, *Cheſter*, or *Liverpool*, at the time of my deceaſe: now in regard of the preſent exigencies and preſſing neceſſities of ſeveral of thoſe perſons, I have thought fit to allot and give out myſelf as a part of that my intended the ſum of 50 *l.* to be divided and diſtributed amongſt ſuch of them, as I do judge moſt neceſſitous for their preſent relief; ſo that now my will is, that my executors ſhall be obliged to pay and diſtribute to and amongſt the ſaid diſtreſſed Iriſh proteſtants in my laſt will mentioned as aforeſaid, no more than the ſum of 150 *l.* (being the reſidue thereof) for the reaſon aforeſaid. And this my codocil I do hereby ſignify and declare ſhall in order thereto be added to and be a part of my laſt will and teſtament. In witneſs whereof I have hereunto ſet my hand and ſeal this fifth day of Auguſt in the year of our Lord God 1691.

Robert Boyle.

SIGNED, ſealed, publiſhed, and declared by the honourable *Robert Boyle*, Eſq; for and as a codicil to be added to and be a part of his laſt will and teſtament, in the preſence of us,

Robert St. Claire,
Tho. Smith,
William Johnſon,
Ja. Oglebey.

WHEREAS I am juſtly ſenſible of the great trouble, that I ſhall give my deareſt and moſt honoured brother and ſiſter, the earl of *Burlington* and *Corke*, and the lady viſcounteſs *Ranelagh*, by my having conſtituted and ordained them to be two of the executors in truſt of my laſt will and teſtament; which, conſidering their age and quality, they may be no way fit to undergo;

undergo; to the intent therefore, that they may be eaſed, as much as in me lies, from all the avoidable trouble of that office, I do hereby declare, that I have engaged my other executor in truſt, Mr. *John Warr*, jun. my preſent ſervant, to take upon him more immediately the troubleſome part of the execution of my ſaid laſt will and teſtament, which he is to proſecute by and according to the direction and appointment of my other two executors, and not abſent himſelf from the ſame during the term or terms herein after mentioned, for which he ſhall happen to be employed in the execution of the ſaid truſt, by travelling above one day's journey from *London*, unleſs it ſhall be on extraordinary occaſion, and with the conſent of my other two executors. In conſideration whereof I do hereby give, deviſe, bequeath, and ſettle upon him, the ſaid *John Warr*, the yearly ſum of 40*l.* for his care and pains in the execution of the ſaid truſt; which, my will is, ſhall be continued to him as an yearly ſalary for the ſpace of three years from the time of the proving my ſaid will, provided the diſcharge of my ſaid truſt require ſo long time; otherwiſe my will is, that this ſalary ſhall be continued but for the ſpace of one year, or at moſt but in proportion for ſuch further time, as ſhall be neceſſary for the diſcharge of the then remaining part of the ſaid truſt. And my further will is, that beſides the ſalary abovementioned, my ſaid executor *John Warr* ſhall be allowed all ſuch neceſſary and reaſonable charges, as he ſhall from time to time expend or be put unto in the performance and execution of the ſaid truſt. Laſtly, my will is, that this codicil ſhall be added to and be a part of my laſt will and teſtament. In witneſs whereof I have hereunto ſet my hand and ſeal the eleventh of September in the third year of the reign of our ſovereign Lord and Lady *William* and *Mary* by the grace of God of *England*, *Scotland*, *France*, and *Ireland*, King and Queen, defenders of the faith, *&c.* and in the year of our Lord God 1691.

Robert Boyle.

SEALED, publiſhed, and declared by the honourable *Robert Boyle*, Eſq; for and as a part of his laſt will and teſtament, in the preſence of us,

Robert St. Claire,
Tho. Smith,
Jo. Caddick,
Will. Johnſon.

WHEREAS in and by my laſt will and teſtament bearing date on or about the 18th day of July laſt paſt I did conſtitute and appoint my deareſt ſiſter *Ranelagh* one of my executors in truſt: and whereas it hath pleaſed God ſome few days ſince to take unto himſelf my dear ſiſter; I do therefore in her ſtead and place hereby make, ordain, and appoint my very loving friend Sir *Henry Aſhurſt* of the pariſh of St. *Sepulchre*'s in the county of *Middleſex*, Knt. and Bart. to be one of the executors in truſt of my ſaid laſt will and teſtament. And I do hereby deſire and impower my ſaid executor, together with my other two ſurviving executors in truſt in my ſaid laſt will named and appointed, to take ſpecial care to diſcharge the truſts by me therein in them repoſed, and more eſpecially that part of my will, that I had particularly recommended to the care of my deareſt ſiſter *Ranelagh* deceaſed. And I do hereby give and bequeath unto the ſaid Sir *Henry Aſhurſt* the ſum of 20*l.* to be laid out by him in a piece of plate. And I do hereby confirm all the appointments of my ſaid laſt will and teſtament, excepting only what therein relates to my ſaid deceaſed ſiſter *Ranelagh*, which I do hereby revoke. And I do hereby alſo confirm all other codicil or codicils, that have been made by me ſince the date of my aboveſaid laſt will and teſtament. In witneſs whereof I have hereunto ſet my hand and ſeal the 29th day of December, in the third year of the reign of our ſovereign Lord and Lady King *William* and Queen *Mary* over *England*, *&c.* *Annoque Domini* 1691.

Robert Boyle.

SIGNED, ſealed, publiſhed, and declared by the honourable *Robert Boyle*, Eſq; as a codicil to and a part of his laſt will and teſtament, in the preſence of us,

Iſaac Garnier,
Robert St. Claire,
Tho. Smith,
William Johnſon,
James Oglebey.

NUMBER III.

Letters relating to the edition of the Iriſh Bible printed and diſtributed at the expence of Mr. *Boyle*. See *Life*, p. 87. and Works, Vol. V. p. 602——614.

I.

Biſhop of Meath *to Mr.* Boyle.

Honourable Sir, *Dublin*, Auguſt 4, 1680.

THE incloſed, from my good friend Dr. *Sall*, ſhould have been (as you find) ſooner with you, but that I made bold to reſerve the paſſing it to you by my good lord the earl of *Ranelagh*, as now; deſigning in both, to be repreſented, and ſo better known to you, than by a bare letter from a ſtranger, I mean myſelf.

BY Dr. *Sall* I underſtand, Sir, your zeal for having this poor ignorant people, the *Iriſh*, informed in the true knowledge of God in their own language, by reprinting the new teſtament, and common prayer in Iriſh, theſe being now out of preſs, and the books of them extant hardly found.

IN addition whereunto is herein offered, the publiſhing of the old teſtament alſo in Iriſh, together with the pſalms in metre fitted to our ordinary church tunes, tranſlated by means and procurement of that learned and pious prelate, Dr. *Bedell*, ſometime biſhop of *Kilmore* in *Ireland*, and provoſt of *Trinity* college in *Dublin*; whoſe heart God had ſtirred up thereunto zealouſly. This was by that learned biſhop himſelf compared with the original, and finiſhed anno 1640. After whoſe death it came into mine hand, where it now continues in ſheets, and MSS. This compleating the bible in Iriſh, and added to what is already printed, would be a work greatly to God's glory, in bringing, by his grace, many from darkneſs to light, and of deſerved praiſe to the happy undertaker.

I HAD once thoughts of repreſenting this to our next parliament here, hoping for public allowance, and ſupplies thereby, toward it. But in diſcourſe with ſome concerning it, I found it almoſt a principle in their politics, to ſuppreſs that language utterly, rather than in ſo public a way to countenance it. This occaſioned what I have ſometime written of that, in an epiſtle to the earl of *Eſſex*, then lord lieutenant of *Ireland*, prefixed to a ſmall tract, which is therefore herewithal for your peruſal; accompanied with another, on another occaſion, both under, Sir, your cenſure.

AS for the Iriſh letters ſtamped for the firſt printing here of the common prayer, and new teſtament; they had paſſed from hand to hand of many his Majeſty's printers in *Dublin* ſucceſſively, until by covetouſneſs of one, into whoſe hands they fell unhappily, they were by the Jeſuits gotten away, and are now at *Doway*, for Iriſh prints; ſome of which I have ſeen, to my grief, ſent hither, further corrupting the people. So as there is nothing left of what was formerly, towards the printing of Iriſh here, if it ſhould be required.

I HAVE dealt with our preſent provoſt of this college of *Dublin*, that he, according to what was ſometimes by Dr. *Bedell*, his predeceſſor, practiſed, would encourage the reading Iriſh; and that Iriſh prayers, *&c.* as others, might be publicly uſed in the college, for thereby fitting out labourers for that harveſt of ſouls, which may, by God's bleſſing ſuch endeavours, be hopefully expected. But even for that, are books wanting, or not ſufficient to be found for it. Therefore the reprinting what is now out of preſs, if there be no more, will be for that good work neceſſary.

I REFER all, Sir, to your conſideration, whoſe heart God hath, I find, enlarged in this, as otherwiſe eminently, to your laſting remembrance, and praiſe every way. And deſiring God's bleſſing you in all your ways, I reſt,

Honourable Sir,

Your moſt humble ſervant,

Henry Midenſis.

II.

Mr. Boyle *to the biſhop of* Meath.

My Lord,

I HOPE your lordſhip did long ſince receive the letter I had the honour to write to you, when I ſent you the forms of ſubſcription, ſucceſsfully employed here, in carrying on the publication of the Welch bible. And though I have not, ſince I ſent that packet, which was above two months ago, received any intimation, that it came ſafe to your hands, yet I

thought it unfit to trouble your lordſhip with another letter ſince that time, becauſe I could not give you in it any good account of the progreſs of our Iriſh teſtament; the preſs, that was to print it, having, as well as others here, been ſo taken up with pamphlets of ſeveral ſizes and kinds, that till of late our work was almoſt quite laid aſide; but now, for want of other employment, I hope the printer will reſume it, and vigorouſly purſue it, partly becauſe he has promiſed to do ſo, and partly becauſe he is ſo far advanced, that he ſays, there is but five or ſix ſheets remaining to be printed off. But I fear the preface will loſe as much time, becauſe the moſt intelligent divine I have adviſed with here about it is earneſt to have the preface, that the Janſeniſts have premiſed to their tranſlation of the new teſtament; which being a piece of great learning and piety, and much eſteemed by the better ſort of the Romaniſts themſelves, it is judged, that if it be publiſhed in Engliſh with no more alterations and additions, than the exigency of our deſign requires, it may very much recommend the introduction of the Iriſh teſtament to the better ſort of Papiſts themſelves, for whoſe benefit it was chiefly made. Mr. *Reily*, that corrects the preſs for the Iriſh teſtament, having been bred in *France*, undertakes the turning this preface into Engliſh; which, as ſoon as he has done, for it is no ſhort one, I ſhall, God permitting, ſend it into *Ireland* to be peruſed by your lordſhip and my worthy friend Dr. *Sall*, and to be made ſuch uſe of, as you ſhall upon the place think fit. I formerly gave notice, that I had ordered my agent in *Munſter* to return up to *Dublin* 50 *l.* in lieu of a ſubſcription towards the printing of the old teſtament in Iriſh; but Sir *John Champanty* having more than once taken notice to me, that the money lies in his hands, I now think it neceſſary to advertiſe your lordſhip of it, and that a direction to pay it in, when your lordſhip ſhall call for it, for the uſe newly mentioned, is intended to be, by the next poſt, renewed to him by,

My lord,

Your lordſhip's moſt humble

[April 8, 1681.] and moſt obedient ſervant.

III.

Mr. Boyle *to Sir* John Champanty.

SIR, *London*, April the 9th, 1681.

FINDING by my ſiſter *Ranelagh*, that you have been pleaſed to receive fifty pound for my uſe, and are deſirous I ſhould diſpoſe of it as ſoon as there is occaſion; I think myſelf obliged to return you my humble thanks for the favour of letting it lie in ſuch ſafe hands as yours, and to inform you, that I intend to employ it by way of contribution to the printing of the old teſtament in the Iriſh tongue, which is carrying on by the right reverend the lord biſhop of *Meath*, and ſome other worthy perſons in your parts. And therefore if his lordſhip, or any duly authoriſed by him, ſhall call to you for the money to be employed to that purpoſe, I deſire you would be pleaſed upon his acquittance to let him forthwith have it; whereby you will further oblige,

SIR,

Your moſt humble ſervant,

Robert Boyle.

The ſuperſcription,
Theſe to my honoured Friend Sir John Champanty,
preſent at Dublin.

IV.

Biſhop of Meath *to Mr.* Boyle.

Honourable Sir, *Dublin*, May 3, 1681.

I HAVE now two of yours (of the 8th and 19th paſt) and thereby underſtand my loſs of a packet not received, which I greatly deſire may be retrieved. (There is nothing from you not deſirable.)

As to that preface of the Janſeniſts, premiſed to their tranſlation of the new teſtament, propoſed to be prefixed to our Iriſh new teſtament; conſidering their refined principles, and even that very deſign of their publiſhing the holy ſcripture in a vulgar tongue; and that that preface paſſeth among the better ſort of Romaniſts themſelves; ſo rendering all, probably, more acceptable to that ſide; it having alſo that approbation you mention of thoſe eminent among us; on all, although I have not yet ſeen it, yet can I not but well approve of your thoughts for tranſlating, printing, and affixing that to our Iriſh new teſtament alſo. Dr. *Sall* is now here with me, to whom I imparted your mind in this, in which is his concurrence alſo.

I HAD,

I HAD, from Dr. *Sall*, ſome time ſince, my firſt intimation of your ſetting yourſelf on that good work of reprinting our Iriſh new teſtament, which I then underſtood to have been intended of both, the common prayer book and new teſtament alſo; both being neceſſary, and out of preſs, and hardly found. But now I find it from yourſelf (in yours of the 19th) that you had not then ſo much as knowledge of ſuch a thing in being, as the common prayer in Iriſh, and publiſhed.

So as our work herein is thereby enlarged; both for printing the old teſtament in Iriſh, which hath not been done hitherto; and for reprinting the common prayer alſo; that ſo all (with what you are now doing) may be complete.

YOUR letters for the work in hand will ſo far eaſe that charge; and what you propoſe of ſubſcription for printing the old teſtament will take in all.

THAT, which leads to this, would be the digeſting that propoſal for ſuch a ſubſcription: that it be not overcharging as to particular ſums; and that it be ſufficient in the total to anſwer the whole work. It may be, what hath been already ordered that way, as to the Welſh bible (which I have not ſeen) may be for this alſo. In ordering which, as to *Ireland*, (for procuring ſubſcriptions, from our clergy in our ſeveral dioceſes, and from others here, and in the ſeveral provinces, as it ſhall require;) this ſhall be (if you pleaſe) my charge herein; if ſome other be at leiſure for furthering ſomething that way there alſo. The ſooner that the ſcheme for this is conſidered and prepared, the better; that by that time that the new teſtament and preface to it (which will take up ſome time) may be perfected, your letters for that work may be free for this, to be done here; or this here to be ſent thither, for being ordered by the ſame preſs, and overſeer, as is the new teſtament at preſent: in which Mr. *Reily*, your overſeer, well deſerves.

As for your 50*l.* left in Sir *John Champany*'s hand, in way of ſubſcription toward the printing the old teſtament, I deſire, that this may be yet under your own ordering, until that work ſhall be under a fuller proſpect, one way or other. In the mean time, and ever, you have your praiſe of piety, bounty, and beneficence, among all good men, in this, and other your good every way manifeſted, and not to be forgotten.

I HAVE communicated to the worthy provoſt of this our college, what you were pleaſed to declare of your intentions for encouraging our Iriſh reader and inſtructor here: which is thankfully accepted, and in your ſo taking notice of that work, will it be much advanced. Be pleaſed, that what in that kind is deſigned may be rather in money than otherwiſe; of which the quantum will be ſufficient, as it is propoſed: that alſo this be conſigned to the provoſt to be ordered accordingly.

As to the teaching and learning Iriſh; that perſon hath read (I hear) a public lecture in the college hall; to which, of the ſtudents, about 80 already reſort: divers alſo of the fellows, and chief of that ſociety, frequent his chamber privately for inſtruction in that kind. And even the provoſt himſelf (not very many years ſince tranſplanted out of *Oxford* hither, and not many months ſince his promoting this good work within this his charge) is become ſo great a proficient already in the knowledge of the Iriſh, that to the teacher's admiration (from whom I have it) he writes the Iriſh perfectly; and is with his own hand tranſcribing the Iriſh grammar, intended for your peruſal and farther conſideration. Of our having ſuch a grammar in our hand, ſome intimation hath been formerly given you. There is, I hear, an Iriſh dictionary in *Bodley*'s library, which the provoſt hath ſent for, for preſent uſe, and to be reſtored.

I SHALL *ſhut this* up, with what I have in my laſt given you joyfully, and with what is ſince then, of the progreſs of Iriſh preaching in this college chapel. The firſt ſunday in each month is deſigned for that. The firſt of that (as you heard) was on Eaſter-day laſt (a day, you well obſerve, for that, and I hope, auſpicious.) The next, was on that day month, May-day laſt (the ſecond of that kind) when the auditory was ſo enlarged, that the whole area of the chapel, with rooms adjoining, above, and below, were unuſually thronged. Among thoſe, were the lord viſcount *Dillon*, and other eminent perſons, and others of the Romiſh profeſſion: which we take for a preſage of yet greater good to the church and kingdom at large, from this happy ſeminary. The lord lieutenant intends to afford his preſence at this exerciſe ſometime, for farther countenance, and encouragement to it. Dr. *Sall* deſigns to preach there next in Iriſh. Let God's bleſſing be on this, and on all, whoſe hearts are ſtirred up by his ſpirit, in this great work; in which you have, I doubt not, a double portion, who firſt promoted it in what you are there doing happily. To his grace and goodneſs I leave you; and reſt,

Honourable Sir,

Your moſt humble and real ſervant,

Henry Midenſis.

HAVING ſome curioſity for obſerving the late comet, I gave what was on that collected to the provoſt here; from whom I ſend in return the incloſed paper, with which I preſent you, as well knowing what uſe to make of it. He was well fitted for ſuch obſervation by inſtruments which he had, and none other that I know hereabout.

V.

Biſhop of Meath *to Dr.* Narciſſus Marſh, *provoſt of* Trinity *college in* Dublin.

Reverend Sir, *Oſberſton*, Aug. 1, 1681.

I RECEIVED yours of the 25th paſt, for which I thank you. My leaving *Dublin* was (I found) about the time of your greateſt trouble, the commencement; and my retiring then into the country, where now I am, was by reaſon of ſome indiſpoſition attending me in that city: both which occaſioned my not waiting on you on my going thence, whereby we might have diſcourſed more freely on the matters in Mr. *Boyle*'s letter, which I ſent you for your peruſal; that occaſioning yours to me mentioned. Nor could I well return him an anſwer to his, until I had firſt adviſed with you concerning it.

In former letters from that worthy perſon, Mr. *Boyle* (like whom, in his way, the age affords not any) I found him zealouſly intent on prefixing the Janſeniſts late prefaces of the new teſtament in French, to the Iriſh new teſtament now under his hand in the preſs; hoping thereby (I conceive) to gain more in the world, in joining ſo far with thoſe of that perſuaſion; they drawing toward us, although not cloſing with us. Hereunto, on that conſideration, I then alſo inclined, although I had not yet ſeen what thoſe prefaces imported.

Since then, I had, by the hand of Dr. *Sall*, the book of the new teſtament in French, with thoſe that Janſeniſts prefaces prefixed. Which their prefaces, for my better information, I had tranſlated, being myſelf a ſtranger to the French.

In reading which I obſerved harſh reflections on ſome of the more eminent and leading proteſtant reformers; alſo other paſſages concerning the difficulty of tranſlations out of the original, on the reaſons therein mentioned: this taking up much paper, and more time, and labour than could be now well ſpared in tranſlating that again out of French into Iriſh.

On which I preſume to offer mine own thoughts, that I know not how convenient would be our tacit owning ſuch reflections on ours as juſt; and whether that might not ſtick with ſome, and not pleaſe others? Or profeſſing to give the world a true tranſcript of thoſe the Janſeniſts prefaces, whether it would be ingenuous by picking and chuſing, to omit any part thereof, on a private account; I mean, the omitting (if that ſhould be) thoſe reflecting paſſages, which might offend? And whether ſuch omiſſions might not diſguſt the Janſeniſts themſelves, whom we would indulge? And whether, either in omitting or not omitting thoſe reflecting paſſages on ours, we ſhould not equally gratify the common adverſary?

In this, I would willingly adviſe with you, Sir; but know not how you can give any judgment herein at preſent, without the firſt peruſal of thoſe prefaces, which you cannot now compaſs, the book being locked up in my ſtudy in *Dublin*, and not to be there readily found but by my ſelf: which yet ſhall not hinder, if you pleaſe to command my going hence to *Dublin*; which on that occaſion I ſhall do, on intimation by you therein given.

As for my ſelf: conſidering what hath been before offered; as alſo the delays to the principal part of the work, the publiſhing of the new teſtament in Iriſh; of which there is ſuch uſe and need at this time; on theſe conſiderations, I ſay, I confeſſed myſelf much biaſſed to the laying aſide the tranſlating thoſe French prefaces in Iriſh; at leaſt for the preſent. And if on farther conſideration it ſhould be after found notwithſtanding adviſeable to take notice of them, that they be prefixed to the old teſtament, or to the common-prayer-book in Iriſh, when publiſhed.

As to the printing of the old teſtament in Iriſh; that being a work of charge and time, toward which, not ſo much as a propoſal is yet prepared, but in its time expected; I ſhould offer, that this alſo be reſpited for a while; and that the common-prayer-book in Iriſh, formerly printed, and now out of preſs, ſhould be firſt reprinted: which, with the new teſtament, ſhortly expected, may well forward that your pious work, in which you have ſo merited of this church and nation.

In all which, I humbly ſubmit to better judgments and to yours in a ſpecial manner; deſiring to hear from you, if you pleaſe; that in my return to Mr. *Boyle*, the whole may be repreſented to him, and alſo left to his ordering.

Thus, deſiring God to bleſs you in that your great charge and work, I reſt,

Reverend Sir,

Your very affectionate

and humble ſervant,

Henry Midenſis.

Biſhop

VI.

Biſhop of Meath *to Mr.* Boyle.

Honourable Sir, *Dublin*, September 3, 1681.

THIS ſeems a tardy return to yours, two months paſt; but the incloſed ſhews me not ſo forgetful:

IN which you find my communicating yours to my good friend Dr. *Marſh*, the worthy provoſt of the college here; whoſe hand in furthering that by you begun, for the good of the Iriſh, in their own lauguage, hath been happy, and every day more ſucceſsful.

HIS thoughts, with mine, you have, in the incloſed, concerning the Janſeniſts prefaces to the new teſtament in French, deſigned for ours alſo in Iriſh; to which I refer, and ſubmit all, howſoever, to what you ſhall judge of it. Dr. *Sall* ſpeaks of preparing a preface, he hopes, fit for our purpoſe; which, when peruſed and allowed by you, ſhall be after tranſlated into Iriſh.

SOME of your copies of the new teſtament reprinted would be very acceptable here, where they are wanting, and neceſſary. Theſe, if you pleaſe, may be conſigned to the provoſt for public uſe.

I AM on the way for procuring one of the Iriſh common-prayer-books; and ſhall find the means for conveying it to you. I ſuppoſe your preſs will be fitter for reprinting that, than any here, ſtrangers to that character and language. But whether there, or here, and how to be carried on, I may after underſtand.

I AM ſurpriſed, in miſſing in that our common-prayer-book in Iriſh the vulgar tranſlation of the pſalms; which until now I never obſerved; it having been a ſtrange omiſſion, that the pſalms, of ſuch daily uſe in reading, ſhould have been neglected. But, I ſuppoſe, that what of the pſalms we have in the body of the old teſtament in the Iriſh MS. (which I have) may ſupply that want, although it be not according to the vulgar, and may be added in the common-prayer-book as the other.

I PERCEIVE by your laſt, that what of yours miſcarried in ſending, was the project concerning your Welſh bible, intended as leading to ours of the old teſtament in Iriſh, when it ſhould be conſidered. But that ſo loſt may be (I doubt not) retrieved ſeaſonably, before we can be ready for the other. For I underſtand by Dr. *Sall*, and others verſed in the Iriſh, that it may be neceſſary, that the Iriſh verſion of the old teſtament in MS. ſhould be firſt reviſed, before it be expoſed to public view. This will take up time; and will require charge alſo, in procuring aſſiſtance, and labours in that kind of ſuch as are of approved abilities for it: among whom I wiſh, if it might be, that Mr. *Reily* might be one. Of this you ſhall hear farther hereafter.

WHAT you had in my former concerning the late comet, was of Dr. *Marſh*, our provoſt's obſervations, which being by him ſent me, I preſented them to yourſelf, who are generally known to be in the recondits of nature, above others, critical.

YOU find alſo ſomething of his in Dr. *Plott*'s Natural Hiſtory of *Oxfordſhire*, pag. 289 — concerning muſic; to which I refer. This I mention, that the genius of that worthy perſon may be better known, his natural modeſty giving him otherwiſe to lie hidden.

I SHALL no farther interrupt your more ſerious thoughts at preſent, but wiſhing you all happineſs, and the reward of your good to all, reſt,

Honourable Sir,

Your very affectionate and humble ſervant,

Henry Midenſis.

VII.

Mr. Boyle *to Dr.* Henry Jones, *biſhop of* Meath.

My Lord,

I MUST begin this letter with my humble thanks for the honour of your lordſhip's of the 3d of this month, which, together with the two incloſed papers, came the ſlowlier to my hands, becauſe they found me not in *London*. As to the verſion of the Janſeniſts preface, I muſt ingenuouſly confeſs to your lordſhip, that the book itſelf, to which it is prefixed, having been got from me, by a perſon of quality, before I had read more than here and there ſome paſſages of the preface, I did, in recommending it, rely leſs upon my own judgment, than that of a very learned and famous divine, and ſome other perſons of eminent parts. And though I was aware of ſome of the objections, that I find in the two judicious papers, and had with Mr. *Reily* taken order to have them obviated in his tranſlation into Iriſh, yet I meet with ſome weighty ones, that I did not (and indeed could not) well know

of; and therefore, as your lordſhip may remember, that in propoſing this preface, I was ready to ſubmit to the better judgment of your lordſhip and your learned friends upon the place, ſo now, upon freſh accounts, I fully refer to you the prefixing what preface ſhall be thought moſt ſuitable to the deſign of the publication, and the particular circumſtances of it and the verſion: in which work I am very glad your lordſhip will have ſo good an aſſiſtant as Dr. *Sall*, who is ſo able a man, and ſo well acquainted with the humour and opinions and prejudices of his countrymen, that I doubt not but he will ſkilfully accommodate his diſcourſe to them. Only, perhaps, it may be thought fit, to make uſe of ſome paſſages of the Janſeniſts preface, not as it is a preface, but as it contains the public avowed ſenſe, and eloquently exhibits the reaſons of famous and eminent divines of the Roman church, for the tranſlating and ſtudying the new teſtament in vulgar tongues. I am, as well as your lordſhip, much ſurpriſed, that the reading pſalms ſhould be omitted in the Iriſh common-prayer-book; but perhaps it will not be for the worſe, ſince it will be neceſſary to ſupply that omiſſion out of your Iriſh old teſtament, in which it is hard, if the pſalms be not better tranſlated out of the original, than if they had been out of the vulgate. I perceive, that, God permitting, there will be time to retrieve the papers, that I ſent your lordſhip, and that miſcarried, about the method uſed in getting ſubſcriptions for the Welſh bible; but by reaſon of the abſence of the manager of that impreſſion, I cannot yet get copies of his papers. But I hope your lordſhip, and the other well wiſhers to the printing of the old teſtament, will not ſtay long for the reviſal of the tranſlation. For though it ſeems very fit, that one ſhould be heedfully made, yet I ſee no neceſſity, that the work ſhould be thereby retarded. For ſome good progeſs may be made in the review, before it will be poſſible to get the firſt ſheet printed; and then it cannot be very difficult for the reviſers to correct at leaſt as faſt as I fear the printer will work off. Whether the edition will be fitter to be made here (as your lordſhip ſeems inclined to think) or at *Dublin*, I wholly leave to be determined by your lordſhip and your friend: and whether here or there, the letters I cauſed to be caſt will be equally at your lordſhip's ſervice. I lately expoſtulated with Mr. *Reily* about the ſhameful tardineſs of the edition of the new teſtament; for which he much excuſes himſelf, laying the whole blame upon the printer, and promiſing, that if the old teſtament be to be wrought off here, he will tie him up very ſtrictly to diſpatch. All which, notwithſtanding I know not, as I was lately intimating, whether *London* or *Dublin* be the fitteſt to be pitched upon for this work; eſpecially ſince here, in caſe Mr. *Reily* ſhould die, or fall ſick, the whole work muſt be at a ſtand, there being none (that I can hear of) in this place fit to correct the preſs. Thoſe ingenious papers about the comet were communicated to a perſon, that I hope will make good uſe of them; and I am glad to know, that I was not miſtaken in thinking they came from Dr. *Marſh*, that I may upon the new ground rejoice, that the college of *Dublin* is happy in ſo learned and worthy a provoſt. Before the receipt of your laſt packet, I was altogether of your lordſhip's mind, that it is not fit all the examplars of the new teſtament ſhould ſtay for the preface (whatever that be) and accordingly, I cauſed copies to be bound the ordinary way, beſides much more handſomly bound, for the preſent uſe of the members of the college, and ſome other perſons, that your lordſhip or Dr. *Marſh* ſhall think fit to ſend any to. And becauſe to have them tranſported by long ſea (though I were adviſed to that, as much the cheapeſt way) would certainly take up time, and might prove hazardous, I reſolved to diſpatch them by land to *Cheſter*, to the poſt-maſter of which place I got them particularly recommended by Mr. *Dowlin*, poſt-maſter of *Dublin*; where, I hope, they will ſpeedily come ſafe, and be delivered to your lordſhip, whoſe long life, health, and ſucceſs in this good work, is heartily prayed for by,

My Lord,

Your lordſhip's moſt faithful

and moſt humble ſervant.

VIII.

Biſhop of Meath *to Mr.* Boyle.

Honourable Sir, *Dublin*, Novemb. 5, 1681.

YOUR laſt of the 27th of September came to hand as I was then entring on a journey into the country, where my preſence was neceſſary, which ſo far occaſions this delay in this return to yours.

THEREIN you mentioned the ſending hither Iriſh teſtaments, ſome (about 50) bound, and others (about 350 in ſheets) then on their way hither from *London*.

THEREUPON I attended our principal officers at the Cuſtom-houſe here, deſiring, when thoſe books arrived, they might be ſafely depoſited under their care, until my return out of the country; the provoſt alſo of the college being then for ſome time in the county of *Kerry*, inſpecting college affairs there, and thereabout.

ON his and my return hither, we found thoſe books here arrived, and laid up accordingly for us about ſix weeks, which, and the bringing them from the Cuſtom-houſe to the college, (where they are laid) was with ſome, but little charge.

IN that your letter mentioned, was alſo intimated ſomething farther expected from you for ordering that parcel of thoſe books, which were not bound; of which nothing hath hitherto come to my hand here, that I can underſtand. Therefore are they laid by, not delivered to any book-binder, until further orders concerning them appear. Theſe are depoſited in the college under the provoſt's care, which I conceived the place proper for their ſafe keeping, and after diſperſing them on occaſion.

As to thoſe books ſent over bound, 40, according to your directions, are left with the provoſt for the preſent uſe of the college.

SOME alſo of the books of the better ſort of binding were preſented as from yourſelf to thoſe great perſons in yours named. Only I preſumed to preſent one of them to the lord lieutenant the duke of *Ormonde*, as from yourſelf (although not mentioned) and found it well accepted by his lordſhip. I conceived this neceſſary, for having his lordſhip's countenance in that great buſineſs when occaſion ſhould require, there being many adverſaries.

THAT which gives greateſt hopes of ſucceſs in this, is our good provoſt's care and zeal in training up the preſent youth in the college in reading the Iriſh, which by the books from you now in their hands is much forwarded.

THESE may be a ſeed plot for the church; the harveſt is great, and labourers few; therefore is the Lord of the harveſt to be earneſtly deſired to prepare and ſend forth more labourers for the great harveſt of ſouls, which we hope for.

WE have received your tranſlation of the Janſeniſts prefaces, and you will ſhortly hear from Dr. *Sall* of his preface alſo. I deſired him firſt to ſend you a copy of that in Engliſh for your approbation, before he entred on his tranſlating it into Iriſh.

I SHALL forthwith put into his hand the Iriſh old teſtament in manuſcript to be by him reviſed. You will alſo have from him the Iriſh common-prayer-book for farther conſideration.

As for the Welſh model for ſubſcriptions, which may direct in our proceeding and forwarding this great work, in that we depend on your procuring it, as you ſhall find your opportunities for it. God bleſs you in all. I reſt,

Honoured Sir,

your moſt humble and real ſervant,

Henry Midenſis.

I CONTINUE to mind you of what I have ſome time ſince written concerning my kinſwoman Mrs. *Loane*, tenant to the earl of *Burlington*, for renewing her leaſe now expiring. I am juſt now ſolicited in this, which occaſions your trouble in it.

IX.

Dr. Anthony Dopping, *biſhop of* Meath, *to Mr.* Boyle.

Honoured Sir, Aug. 3, 1682.

I MUST needs acknowledge it as a great omiſſion in myſelf, that I have ſo long delayed an anſwer to your kind and obliging letter, which I had the honour to receive a conſiderable time ſince: and as I deſire not to make any apology for my neglect, ſo I hope you will be inclined to pardon it, upon my promiſe of offending no more in this nature. As for the deſign on foot about the Iriſh old teſtament, it goes on, though by ſlow and leiſurely ſteps, but I doubt not within a ſmall time to procure (from ſome well affected perſons to the work) ſuch ſubſcriptions, as may add little more of life and briſkneſs to the undertaking; and I hope we may effect this without putting you to the trouble of ſending the formularies of ſubſcriptions for the Welſh bible: but I preſume our ſubſcribers here will expect a book, when it is printed; and if ſo, I am afraid, that the printed copies deſigned may but anſwer the number of ſubſcriptions, and ſo the publickneſs of the work be prejudiced by it. How to obviate this I leave it to your prudence and judgment to conſider and contrive an expedient; to whom, as the glory of the undertaking is entirely due, ſo I ſhould think myſelf very criminous, if you were not made acquainted with all the hazards that fœtus muſt run through, which owes its birth to your care and charity. Thus with my humble reſpects I remain,

Honoured Sir,

your moſt humble and obedient ſervant,

Anth. Midenſis.

Biſhop

X.

Biſhop of Meath *to* * * *

Reverend Sir, December 14, 1685.

YOUR letter, which I received yeſterday, would have been very obſcure to me, if you had not ſent me Mr. *Boyle*'s incloſed in it, as a key to open the ſenſe of ſome things in it. As to the title page, mentioned in his letter, I can ſay nothing to it, being a ſtranger to the tranſactions between him and you concerning it: as to the preface, if by it be meant that, which I ſent you, I am much of Mr. *Boyle*'s opinion, that it is improper to have it in Engliſh, and that I intended it to be tranſlated into Iriſh, had not your letter to me imported, that the preſs ſtayed for it. But ſince it is now out of my hands, and Mr. *Reily* hath obtained a deſerved character for his knowledge in the language of his own country, I know of no perſon more fit to be employed in it than himſelf.

As for an hiſtorical account of the verſion, I dare not undertake to tell the world, that it is impartially done from the original, having no knowledge of the language of my own country: all that I can add concerning it, is only this, (which, if Mr. *Boyle* thinks fit, may be farther enlarged in its exterior dreſs, but very little, as to the ſubſtance) that in the convocation held at *Dublin* 1634, there were no ſmall debates about the verſion of the bible and the liturgy of the church into the Iriſh tongue, for the benefit and inſtruction of the natives; Dr. *Bedell*, biſhop of *Kilmore*, being for the affirmative, and Dr. *Bramhall*, biſhop of *Derry*, oppoſing it. The reaſons of the former were drawn from the principles of theology, and the good of ſouls; of the latter, from politicks and maxims of ſtate, and eſpecially from an act of parliament, paſſed in this kingdom in the reign of King *Henry* VIII. for obliging the natives to learn the Engliſh tongue. However, the reaſons of biſhop *Bedell* were thought ſo ſatisfactory (eſpecially being countenanced by the authority of primate *Uſher*) that the convocation thought fit to paſs two canons concerning it; the one, that the miniſter ſhould read the liturgy in Iriſh, where moſt of the people were ſo, can. 8. the other for the pariſh clerk to accompany the miniſter in reading his part of the ſervice in Iriſh, can. 66.

UPON theſe foundations the pious biſhop *Bedell* reſolved to make farther ſuperſtructures; and accordingly ſet himſelf to the verſion of the old teſtament into the Iriſh tongue (for the new had been done before at the expences of Sir *William Uſher*, clerk of the council of *Ireland*, and by the care of Dr. *Daniel*, who was after made archbiſhop of *Tuam* in *Ireland*) taking to his aſſiſtance, one Mr. *King* and Mr. *Dennis Sheridan*, both Iriſhmen and clergymen, and excellently ſkilled in the language of their own country, whoſe office it was, to tranſlate the then Engliſh verſion into Iriſh, whilſt the biſhop (who was excellently learned in the Hebrew and the Iriſh languages) reviſed the whole work, comparing it with the original, and either expunged, or added, as he ſaw it nearer or more remote from the original. The work, thus happily finiſhed, was left, by biſhop *Bedell*, with Mr. *Sheridan*, the tranſlator, (who ſurvived him) and was by him delivered to the late biſhop of *Meath*, Dr. *Henry Jones*, by him communicated to Dr. *Andrew Sall*, from whom I received it before his death, and gave it to your predeceſſor, Dr. *Marſh*; and what fate it hath met with ſince, he and others, whoſe hands it hath paſſed, can beſt relate.

SOME part of this narrative I have read in the life of biſhop *Bedell*, lately publiſhed by one *Clogy*, who is ſomewhere beneficed in *England* (if he be alive) and married the ſaid biſhop's daughter, and may be more particular, if conſulted. If I have miſtaken any thing (as perhaps I may, as to the name of *King*, for I have not the book by me) that book will rectify it: the remainder, relating to Mr. *Sheridan*, you may receive a more ample account of from the biſhop of *Kilmore*, who is his ſon. I have ſent you Mr. *Boyle*'s letter, conceiving, that it may import you more than me. I ſuppoſe the title page ought to be in Iriſh characters firſt, and then in Engliſh; with this inſcription in both: *The Books of the Old Teſtament tranſlated into Iriſh, by the Care and Diligence of Dr.* William Bedell, *late Biſhop of* Kilmore *in* Ireland, *and now printed for the public good of that Nation.* London.

IF Mr. *Boyle*'s modeſty would permit, I judge it neceſſary, that at the end of the preface, ſomething be inſerted concerning his bounty in the printing it at his own charges, that the nation may know their obligation to ſo worthy a benefactor. I remain,

SIR,

Your moſt humble ſervant,

Anthony Midenſis.

PREFACE

XI.

PREFACE to the IRISH NEW TESTAMENT.

To the Chriſtian people of *Ireland*.

HERE you have, dear countrymen, the new teſtament of our bleſſed Lord and Saviour Jeſus Chriſt preſented to you, in your country garment, tranſlated unto the Iriſh tongue; and therein the moſt noble, the moſt important, and, to well diſpoſed minds, the moſt pleaſant reading, that poſſibly can be offered to their view. I ſay, the moſt noble, whether you conſider the Author of it, being the very wiſdom of God, his divine Son Jeſus, and his holy diſciples taught by himſelf, and by the Holy Ghoſt guiding their pens; whether you look upon the ſubject of this ſacred book, which is the knowledge of divine myſteries, and of the way leading to your everlaſting happineſs; in which conſideration you find alſo the ſupreme importance of this ſacred reading, as guiding you to the kingdom of heaven. And what availeth you to purchaſe all that the world can afford, if you ſhould fall ſhort of that glorious enjoyment? And if God hath commanded his people to read continually the law, which he hath given them, and to meditate therein day and night; and if ſocieties, aſpiring to ſome peculiar degree of perfection, do believe they are obliged to read always the rules they have taken to that end; we, that are by God's mercy *called unto the fellowſhip of his Son Jeſus Chriſt our Lord*, how ſhall not we think it our moſt neceſſary duty to read, and continually to meditate in the law he has left us as a teſtament and pledge of his inheritance? 1 Corin. i. 9.

FINALLY, the unſpeakable pleaſure of this ſacred reading was well experienced and frequently atteſted by thoſe godly ſouls, who happily have exerciſed themſelves in it. Them you may conceive ſpeaking to the Author of this book, in the Pſalm cxviii. 103. *How ſweet are thy words unto my taſte! yea ſweeter than honey to my mouth*; and in that of *Canticles* iii. *Thy ſpeech is comely.* St. *Clement Martyr* declares, that whatſoever may be deſired for harmleſs pleaſure or profit in profane books, the ſame may be found far more advantageouſly in the ſacred ſcripture, of which he maketh himſelf a large and fair induction, running upon the contents of ſeveral books of the Holy Bible. And St. *Auguſtin* ſays, that *as the ſtore of gold, ſilver and garments, which the Iſraelites brought out of Egypt, was but mean, in compariſon of what they found after in Jeruſalem, as may appear by the wealth of King Solomon: ſo any purchaſe of knowledge got in the books of heathens, is nothing, being compared to the ſcience of ſacred ſcripture.* Clement. lib. 1. conſtitut. apoſtolic c. 7. Aug. lib. 2. de doctrin. Chriſtian. c. 41.

AND this being true enough, ſpeaking of ſcripture in general, is ſingularly evidenced in this divine volume of the new teſtament of our Lord and Saviour Jeſus. For if you are for the pleaſure of hiſtory, relating wonderful ſucceſſes, other records may repreſent to you men overcoming other men, cities, or wild beaſts: but here you ſhall find a divine man ſubduing the world without worldly arms; the ſea and winds, and all the elements, even the devils, obeying his commands; death itſelf, which trampleth all human power, overcome by him, raiſing others and himſelf from under the power of it, and mounting with his own proper power over the clouds and ſkies unto the higheſt heaven. In the Acts of the Apoſtles you ſhall meet with the like prodigies wrought by his diſciples, illiterate ſimple men triumphing over the ſwelling ſcience of the ſages of this world, kingdoms and nations obeying their word. If you deſire moral inſtructions, for ruling your life and ſteering the courſe of it to everlaſting reſt, you have in the ſermons and precepts of our Saviour ſpread over the Goſpel, and in the epiſtles of his bleſſed apoſtles, the very treaſure of knowledge given to you by God, for that purpoſe, and the moſt excellent ſyſtem of ethics and theology, that ever was ſeen in the world, all virtues heretofore known to men there commended and exalted, and others more ſublime, never before practiſed in the world, taught by our Saviour and his diſciples in their precepts, and moſt powerfully by their examples. St. *Chryſoſtom*, gloſſing upon the admirable meekneſs of *David*, ſparing his inveterate enemy in the cave of *Engeddi*, 1 *Sam.* xxiv. exhorteth all men to print in their hearts, that paſſage; *for it is impoſſible*, ſaith he, *that a mind converſant in ſuch kind of hiſtories ſhould be overcome by paſſions.* And is it poſſible, that a man, reading in the Goſpel and in the Acts of the Apoſtles, ſo many prodigious examples of humility, meekneſs, and patience, practiſed by our Saviour and his bleſſed diſciples, ſhould be overcome by pride, vanity, or impatience? When he finds the Son of God chearfully bearing affronts offered to him by vile men; when he ſees the holy apoſtles rejoicing, that *they were counted worthy to ſuffer ſhame for his name*, Acts v. 41. ſhall he be ſtartled at every ſmall injury received? Chryſoſt. homil 1. de David & Saul.

AND laſtly, if you are for a ſublime extatic contemplation of heavenly myſteries, you have in the venerable prophetic deepneſs of the Apocalyps ſparkles of divine light, which in pious and humble ſouls do work a profound reſpect of God's infinite grandeur and majeſty.

IF any ſhould ſay, that this precious treaſure ſhould be reſerved for the learned in the original or ſchool languages, and not expoſed to popular eyes in the vulgar ones; whatever be the weight of this conſideration, it has been over-ruled already by all Chriſtian nations, *Italy*, *Spain*, *France*, *Germany*, *England*, and all other kingdoms and countries of the Chriſtian world, do enjoy the glorious light of divine ſcripture in their native idioms. The learned

doctors in divinity of the univerſity of *Paris* have reprinted of late the new teſtament in the French language, following therein the examples of the doctors of *Louvain* in the ſame faculty, who had ſet forth the whole bible in the ſame language, and bemoaning in the preface of their edition the ſad effects of the common neglect of reading the holy ſcripture in theſe latter times of Chriſtianity, far otherwiſe than it was in the more holy primitive ages of it. All the writings of the holy and learned fathers of the church are repleniſhed with marks of their reſpect to the word of God delivered to us in the holy ſcripture, exhorting all men to the reading and knowledge of it. The Goſpel, ſay they, is the mouth of Chriſt: he ſits in heaven, but ſpeaks continually on earth. How then dares that man call himſelf ſervant of Chriſt, who cares not to know what he ordains him to do? or how can he obey him, if he ſlights to hear him? The precepts of the Goſpel, ſays St. *Cyprian*, are the foundation of our hope, and the nouriſhment of our heart. It is in this reading we find light to guide us, ſtrength to uphold us, and remedy to heal us. This made *Cæſarius*, biſhop of *Arles*, to ſay, that thoſe very men, who are not able to read, may not be excuſed from attaining to a competent knowledge of the ſoul-healing doctrine of the Goſpel; for if even ſuch men do find means to learn idle and leud ſongs and romances, with more reaſon they ſhould apply themſelves to learn the heavenly doctrine of ſcripture. And that they may the better do it, the foreſaid learned doctors of *Paris* and *Louvain*, as alſo other pious and learned men in all nations of Chriſtendom, have taken care to tranſlate the holy ſcripture into the vulgar language of their countries, that the divine doctrine of it may more eaſily come to the knowledge of all ſorts of men. And that *Ireland*, ſometimes inferior to few of the nations in piety and learning, might not be deprived of the like happineſs, has been the pious zeal and care of worthy patriots, whoſe names ought to be with praiſe continued in the memory of poſterity. Such we find to have been *John Kearney*, ſometimes treaſurer of St. *Patrick*'s church in *Dublin*; *Nicholas Wailſh*, biſhop of *Oſſory*; *Nehemiah Odonelan* and *William Odonel*, both archbiſhops of *Tuam*, by the help of others, ſkilful in the *Iriſh* tongue, the province of *Conaught*, and Sir *William Uſher*, clerk of the council, bearing the charge of the firſt edition of the new teſtament in Iriſh.

And now again, that edition being worn out in time, and few copies of it to be found, God has raiſed up the generous ſpirit of *Robert Boyle*, Eſq; ſon to the right honourable *Richard*, earl of *Corke*, lord high treaſurer of *Ireland*, renowned for his piety and learning, who hath cauſed the ſame book of the new teſtament to be reprinted, at his own proper coſt. And as well for that purpoſe, as for printing the old teſtament, and what other pious books ſhall be thought convenient to be publiſhed in the Iriſh tongue, has cauſed a new ſet of fair Iriſh characters to be caſt, in *London*, by a ſkilful artiſan, and an able printer to be inſtructed in the way of printing this language; and having appointed five hundred copies of this new edition to be beſtowed on ſuch, as ſhall be thought to make the beſt uſe of them, has extended his charitable zeal towards the printing of the old teſtament in Iriſh, giving both the uſe of his characters for that purpoſe, and fifty pounds of his money for a beginning to ſubſcriptions for the publiſhing of it. We cannot but hope, that God will excite the ſpirits of other pious men to follow the heroic example of this noble man, in furthering this holy work, for the good and comfort of many poor ſouls, pitifully deſolate and blinded, for want of the heavenly light of the word of God to ſhine among them.

If any other ſhould further ſay, that holy ſcripture, tranſlated unto common language, ſhould not be generally permitted to all men's reading, becauſe ſome, by the ill uſe, and wrong underſtanding of it, have raiſed ſchiſms and many diſturbances; it may be anſwered, firſt, that this argument proving too much proves nothing by the ordinary rules of arguing. It proves too much, becauſe churchmen and the more learned ſhould be prohibited the reading of ſcripture more carefully upon this account, whereas *Arius*, *Pelagius*, *Neſtorius*, and other prime hereſiarchs, were churchmen, and of eminent learning. Secondly, that becauſe children do cut their fingers with knives, and wicked men do murder others with ſwords, knives and ſwords muſt be taken from all upon the like account. The remedy therefore is to be, not to take away knives and ſwords, and leſs the ſcripture, but the evil uſe of them. To avoid this, and find the ineſtimable treaſure encloſed in ſacred ſcripture, let piety, humility, and diſcretion guiding both, be their companions in reading it. Let their piety appear in ſeeking ſincerely the will of God, and the way to him in that holy reading. Let their humility ſhine in not relying too much upon their own judgment in the expoſition of ſcripture, where it is obſcure, but praying to God, and ſeeking the help of the moſt warrantable teachers for the right underſtanding of it; in the choice of which teachers, their diſcretion is to be practiſed, relying more upon the moſt ancient, moſt holy, and moſt generally approved in the Chriſtian church.

And if, after uſing their beſt endeavour to find out the right underſtanding of ſcripture, ſome places of it ſhould continue obſcure to you, take from the learned, humble and holy-doctor, St. *Auguſtin*, this excellent leſſon, for judging of thoſe ſacred books: *Where I underſtand them*, ſays he, *not only nothing can be more wiſe, but alſo nothing ſeems to me more well ſpoken: and where I do not underſtand them, their eloquence is not ſo apparent to me; but, even then, I do not doubt, but it is ſuch, as where I do underſtand them.* God were not God, if to be comprehended by human wit. If any of his words ſeem to you not ſo agreeable to reaſon, make ſure account the fault lies in your weak underſtanding; wait patiently, pray and read again,

Aug. lib. ult. de doct. Chr c. 6.

and hope in God's mercy, that he will open your eyes to a right underſtanding; and the more often you read, the more light you ſhall daily receive. Mark what the ſame great doctor St. *Auguſtin* declareth of his own experience. *I do publicly avouch*, ſays he, *the depth of Chriſtian ſcriptures to be ſuch, that I would daily have more and more to learn in them; though from my childhood to decrepit old age, I ſhould with full leiſure, moſt eager ſtudy, and greater wit endeavour to learn them.* But the ſame holy and learned doctor giveth you for comfort, what is certainly true, that in what is plain of ſcripture you have all that is neceſſary for your inſtruction, both in belief and in a good life, which made St. *Paul* writing to *Timothy* tell him, that *the holy ſcriptures, which from a child he had known, were able to make him wiſe unto ſalvation.* Whereof he giveth the reaſon, adding immediately, that *all ſcripture is given by inſpiration of God, and is profitable for doctrine, for reproof, for correction, for inſtruction in righteouſneſs; that the man of God may be perfect, thoroughly furniſhed unto all good works.* Aug. epiſt. 3. 2 Tim. iii. 15, 16, 17.

Now therefore the excellency of this holy book being ſo incomparable, and ſo vaſt the importance of it, it is the expectation of the pious and learned men, who have laboured in publiſhing it, and their earneſt requeſt even for Chriſt Jeſus his ſake, that all good Chriſtians capable to make uſe of it, ſhall in their reſpective ſtations reverently frequent the reading of it, for the benefit of their own ſouls, and of others about them, or under their charge; and more eſpecially, that all godly churchmen, who have the cure of ſouls, may read, or cauſe it to be read to their congregations, whereto underſtanders of the Iriſh tongue do reſort, or upon this encouragement may reſort more; conſidering, that no preaching is ſo effective to work upon ſouls, as the very *word* of *God*, which, as St. *Paul* ſays, *is quick and powerful, and ſharper than any two edged ſword.* For the ſame reaſon, pious fathers of families ſhould cauſe it to be read on fit ſeaſons to their houſhold, inuring them to a deſerved love of this ſacred reading, in lieu of romances, and other idle or noiſom divertiſements. Foreigners alſo, who deſigning to continue their habitation in *Ireland*, will, by the rules of common prudence, deſire to purchaſe a knowledge of the language, may attain it by reading this book, comparing each chapter of it with another of the ſame contents in the language they underſtand; for which purpoſe ſome ſhort rules have been already, and more ſhall be publiſhed, for the right pronouncing and reading of the Iriſh tongue. Heb. iv. 12.

FINALLY, ſtudents in ſchools and univerſities, who deſign to live by the cure of ſouls in *Ireland*, ſhall upon a ſerious conſideration find it their preciſe duty to procure ſuch knowledge in the language of the natives, as may enable them to help and inſtruct the ſouls committed to their charge, and of which they are to give account to God; for notwithſtanding all the wiſe ſtatutes and endeavours uſed to bring this whole nation to a knowledge of the Engliſh tongue, experience ſhews it could not be effected, too many being unable to give ſuch teaching to their children, or to get it for themſelves; and it is apparent, that in *Ireland* there are many pariſhes, baronies, and whole counties, in which the far greater number of the common people do underſtand no other language but the Iriſh. This being ſo, how can it be preſumed of any godly paſtor of ſouls in ſuch places, that he ſhall not procure the ſpiritual welfare of thoſe men, by the ſweat of whoſe brows he hath his bread, enabling himſelf to preach, read to, or converſe with them in a language they can underſtand, that being the way to gain their good will, and thereby to win their ſouls to God? For very true and experienced is what *Ariſtotle* ſaid, *plurimas amicitias taciturnitas ſola diſſolvit*, that want of communication breeds want of love and union. And to gain their affection is the way to benefit their ſouls, and cure them of the moſt deplorable blindneſs they are in, ſitting long time *in darkneſs and in the ſhadow of death*, for want of ſetting before them the heavenly light of the word of God, which his loving providence hath given as *a lanthorn to our feet*, in this our pilgrimage towards our deſired home of heavenly glory. And now the Lord and giver of it, our dear Saviour Jeſus, who hath inſpired the thoughts of publiſhing this ſacred book for the good of ſouls, be graciouſly pleaſed to grant all others concerned to make due uſe of it towards the glory of God, and the ſpiritual welfare both of others and their own. Amen. Pſal. cxix. 104.

NUMBER IV.

Letters and papers relating to the diſtributing of the Iriſh bibles in the *Highlands* of *Scotland*, at the expence of Mr. *Boyle*. *Life*, p. 87.

I.

Mr. Kirkwood's *letter to Dr.* Wotton, *containing a general account of Mr.* Boyle's *concern in the edition of thoſe bibles.*

Reverend Sir, June 22, 1702.

I AM glad you are going to publiſh the life of the excellent Mr. *Boyle*, who was ſo great an ornament to his country and to our holy religion. I reckon it one of the bleſſings of my life, to have been acquainted with ſo extraordinary a perſon, whoſe company I found always

always very delightful and edifying. It was ſoon after our acquaintance was begun, that I had the opportunity of talking with him of the ſad ſtate of religion in the *Highlands* of *Scotland*, where they had neither bibles nor catechiſm in their own language. This gave him an occaſion to tell me of his having cauſed five hundred bibles in Iriſh, in a quarto volume, in the Iriſh character, to be printed for the uſe of thoſe in *Ireland*, who underſtood not the Engliſh. He then offered a few of thoſe bibles to be ſent into *Scotland*, to ſee what reception they might meet with there: a dozen of them was firſt ſent, and afterwards two hundred; which made one for each pariſh. In ſuch places, where theſe books were diſtributed, they had a very good effect, as you may perceive more fully by the papers relating to that affair, which I ſend you. After ſome time, I heard from ſome miniſters in thoſe parts, that it was the earneſt deſire of many, who wiſhed well to our religion, to have a new impreſſion of the bible in the Latin character, in a ſmall volume, for the uſe of ſuch perſons in the *Highland* pariſhes, as had been taught to read Engliſh, though they did not underſtand it, and for the advantage of ſuch children, as ſhould be ſent to ſchool, eſpecially thoſe of the poorer ſort, who could not purchaſe books for themſelves. To anſwer the pious deſires of ſuch perſons, endeavours were uſed in *Scotland* to procure another impreſſion; but in this attempt we met not with ſucceſs. The firſt encouragement, that was given me to go on with it in this kingdom, was by the worthy Mr. *Boyle*, who told me, he would ſubſcribe for printing one hundred bibles. This example diſpoſed others, whom I acquainted with the deſign, to ſubſcribe very freely and largely. Moſt of the ſubſcriptions you will ſee in the printed paper I ſend you relating to that affair. I need not mention other particulars, only in ſhort, after ſome few years, this work was happily finiſhed, the books were printed, tranſmitted into *Scotland*, and long ago the greateſt part of them was diſperſed in the ſeveral counties of the *Highlands*. We have had many accounts of the happy effects, which have attended our endeavours, in behalf of thoſe poor people, who have been ſo long neglected and ſuffered to remain in a ſtate of ignorance and barbarity. By the printed paper you will likewiſe ſee, that there were ſix thouſand catechiſms and prayer-books in Iriſh printed at the only charge of Mr. *Boyle*, for the uſe of the Highlanders, which were accordingly ſent down into *Scotland*; many of which have been likewiſe diſperſed among the Highlanders. The catechiſm and prayers were compoſed by Mr. *Charteris*, and were tranſlated into Iriſh by Sir *Hugh Campbell*, of *Caddell*, and afterwards reviſed and corrected by Mr. *Kirk*. There were added to the catechiſm ſome paſſages of ſcripture, containing the principal heads of the Chriſtian religion, to ſerve as a ſhort and plain tract of devotion and Chriſtian morality. It was this catechiſm and prayers, that are mentioned in the biſhop of *Roſs*'s letter. As for the papers I ſend you, which have ſome relation to that great man, I leave it to you to make uſe of them, or any part of them, in ſuch ſort, as you judge may beſt ſerve your deſign. When you have done with them, be pleaſed to return them to me again, to be left for me at Mr. *Milbourn*'s a watchmaker at the *Blue Boar* in the *Old Baily*, near *Ludgate*, *London*. As for the letter from Mr. *Charteris*, I ſend it you, that you may ſee the high opinion, that pious and primitive perſon had of the famous Mr. *Boyle*. As for Mr. *Boyle*'s own letter, the chief reaſon why I ſend it, is upon the account of ſome few ſeaſonable expreſſions in it about education, which may be very well improved in ſome part or other of his life. As for the letter from Mr. *Kirk*, a Highland miniſter, who was corrector afterward of the preſs, when the Iriſh bible was reprinted, perhaps it will furniſh you with ſome hints not unuſeful to your deſign. I need ſay no more as to this matter. I heartily wiſh you may have good ſucceſs in what you are about, that you may be able to ſet forth ſo great a pattern and example in ſuch a light, as may move others to have a higher regard for ſolid piety, and uſeful learning. Before I conclude this letter, I muſt acquaint you with another deſign, which has been ſet on foot, in behalf of the miniſters, ſchool-maſters and probationers, in the *Highlands*. The reaſons of this deſign you will ſee in the printed paper I ſend you. They, who are now in the government there, have ſo far eſpouſed it, as to recommend it to the ſeveral preſbyteries to promote it. I know your good affection to religion and learning will diſpoſe you to encourage a work of this tendency, which is likely to prove of very great uſe and advantage. Your neighbour, Mr. *Frank*, can acquaint you with ſome farther particulars relating to this affair. I am,

Reverend Sir,

Your affectionate brother,

and humble ſervant,

JA. KIRKWOOD.

II.

An account of the deſign of printing 3000 bibles in Iriſh, for the uſe of the Highlanders.

THE inhabitants of the *Highlands* of *Scotland* have never had the bible in their own language, which is the Iriſh. Some endeavours have formerly been uſed in *Scotland*, to have it printed in that language, but hitherto they have proved unſucceſsful. Of late the

honourable and pious and learned Mr. *Boyle* hath, at great charge, cauſed to be printed 500 bibles in Iriſh, which were deſigned for *Ireland*; and accordingly moſt part of them, eſpecially the new teſtaments, were by him ſent thither. Of the books of the old teſtament which remained, he ſent above two hundred into *Scotland*, which made one book for each pariſh in the *Highlands*, there being ſo many pariſhes in thoſe parts, which are of very large extent, containing great numbers of people. The ſame excellent and worthy perſon was at the charge of printing, for the uſe of the Highlanders, 3000 catechiſms and prayer-books in Iriſh, with ſome paſſages of ſcripture, containing the principal heads of the Chriſtian religion, they never having had any ſuch helps before. He hath alſo lately given money for to reprint as many more. Several of thoſe bibles and catechiſms have been diſtributed among ſuch pariſhes in the *Highlands* as are near *Edinburgh*, and where the preſent commotions have not prevented their being ſent. The reſt will now be ſent very ſpeedily. In all thoſe places, where they have been ſent, the people expreſs a wonderful joy, and a great deſire to know the word of God; ſo that they, that can read, are at ſome pains to teach others to read likewiſe. And ſuch is their zeal, that they ſend for the bible ſometimes to one part of the pariſh, and ſometimes to another, that they may read on the week days; and then they return it to the church on the Lord's day, that all may hear it read publickly. And it is very remarkable, that amidſt the publick commotions in that kingdom, ſcarce any of thoſe Highlanders, who have received bibles and catechiſms, and have been inſtructed in the knowledge of truth, have joined themſelves to the adverſaries of the preſent happy ſettlement. All ſort of people among them expreſs an earneſt deſire to have another impreſſion of the bible in Iriſh for themſelves and for their children, that by reading and hearing of that ſacred book, they may be delivered from ignorance and barbarity. The money collected for carrying on the work is to be depoſited with the reverend doctor *Horneck*, who hath been pleaſed charitably to accept of the trouble of receiving it. Several worthy perſons both of *England* and *Scotland*, have promiſed their concurrence, and ſignified the proportions they intend to give, of whom alſo not a few have already ſent their money to Dr. *Horneck*, at his houſe in *Exeter-ſtreet*, who hath a liſt of their names, with the ſums of money they have ſubſcribed or ſent. They, who have not yet ſent their money, are deſired to ſend it as ſoon as may be. The perſon employed for the printing this bible is *Robert Everingham* at the *Seven Stars* in *Ave-mary-lane* nigh *Pater-noſter-row*. Mr. *Robert Kirk*, miniſter of *Aberfoyle* in *Monteith* in the *Highlands* of *Scotland*, is come to *London* to attend the preſs. The work is now begun, and will be finiſhed (God willing) before Chriſtmas next. The books, which are ſubſcribed for by ſome charitable perſons of this kingdom, are to be diſtributed (by the advice and with the concurrence of perſons of public authority in the kingdom of *Scotland*) amongſt the poorer ſort of Highlanders. As for the books, which are ſubſcribed for by thoſe of *Scotland*, they are likewiſe to be beſtowed on poor people, ſo far as is needful; and as for the money, which ſhall be got from thoſe Highlanders, who are able to buy books for themſelves, it is to be kept in ſtore, as a fund for another impreſſion of the bible in Iriſh, or for printing ſome ſuch uſeful treatiſe in that language, as ſhall afterwards be thought moſt proper. We have ſufficient reaſon to expect, that ſchools will be ſettled in all pariſhes of the *Highlands*, that thereby this charitable deſign may be rendred effectual. This will be ſhortly recommended to the care of the parliament in *Scotland*. The paper and printing amounts to 275 *l.* at 1 *s.* 10 *d.* per book in quires, the binding (at 8 *d.* per book) amounts to 100 *l.* which in all makes 375 *l.* Towards which, we have the following ſubſcriptions, which amount to 244 *l.* 8 *s.* 8 *d.* So that there is wanting to complete the charge of paper and print 30 *l.* 11 *s.* 4 *d.* and for binding, 100 *l.* in all wanting 130 *l.* 11 *s.* 4 *d.* There are alſo new teſtaments to be printed, for the uſe of young children learning at ſchool, the number of which will be proportioned to the money that ſhall be given.

	l.	*s.*	*d.*
Mr. *Boyle* gave for this charitable uſe	8	6	8
As alſo did ſeveral other perſons the ſum	236	2	0
Total amounting to, with Mr. *Boyle's*,	244	8	8

III.

An anſwer to the objection againſt printing the bible in Iriſh.

IT is not to be doubted, that a great many, who make this objection, do it without any bad deſign, but only through their not conſidering the matter ſufficiently. And therefore to remove their miſtake and prejudice, the following conſiderations are offered unto them, whereby theſe two things will appear. 1ſt, That the extirpation of the Iriſh language, out of the *Highlands* of *Scotland*, is not poſſible in this age. And ſecondly, That it is not probable to be effected in ſucceeding ages. As to the firſt, it may appear ſufficiently to any, who will conſider the methods of doing it. As 1ſt, By colonies. 2dly, By ſcattering the Highlanders all over the nation. 3dly, By ſchools. 4thly, By ſending their children to ſerve in other parts of the kingdom, and ſo to learn Engliſh. As to the firſt, if ſeveral colonies ſhould

be ſent among them, what could they do towards the extirpating the language, unleſs we ſhould ſuppoſe them more numerous than the inhabitants, which is impracticable? For neither could the reſt of the nation ſpare ſo great a number of people, nor yet could the barren mountains of the *Highlands* afford them the conveniencies of life. Beſides, the Highlanders not living in towns, but ſcattered up and down in very ſmall villages and ſingle houſes, the ſettling of colonies among them could not ſignify much to root out their language. As to the 2d of ſcattering the Highlanders all over the nation, it is an idle dream, not at all practicable; for neither would the generality of the Highlanders leave their native ſoil, nor yet would others readily receive them. And, 3dly, As for ſchools, neither can they do it: for firſt we may ſuppoſe, that there will be ſtill too many, who go not to ſchool through the poverty and negligence of the parents, and uncharitableneſs of richer neighbours: now thoſe, that tarry at home, muſt needs retain their own language. 2dly, We may very reaſonably ſuppoſe, that many, who ſend their children to ſchool to learn to read Engliſh, are not able to keep them ſo long under the care of a ſchoolmaſter, as to have time to learn to ſpeak it, though they may have time to read and underſtand it pretty well in books. 3dly, Suppoſe one of ten or five children, who are ſent to ſchool, ſhould learn it perfectly to ſpeak it, and underſtand it when ſpoken, yet what is this to the extirpating the language in this age? What muſt be done with the four of five or the nine of ten children, not to ſay any thing of aged perſons, who cannot ſpeak Engliſh? Ought not care to be taken, that they periſh not for lack of knowledge? Or ſhall the bleſſed means of heavenly light and comfort be with-held from them, as from a generation, that God hath curſed and forſaken? Far be it from all thoſe, that bear the honourable name of Chriſtians, to harden themſelves againſt their brethren, and under pretence of any human policy to fight againſt the kingdom of our God and Saviour. As to the fourth, to wit, ſending children from the *Highlands* to ſerve in thoſe parts, where they ſpeak Engliſh, it can ſignify but very little; for there are not many (in compariſon) who can be ſent into other parts of the kingdom; and it is known, that many, who have continued for ſome years in thoſe parts, where they ſpeak Engliſh, have never acquired ſo much ſkill in that language, as to be able to underſtand a ſermon in it. As to the ſecond thing, that it is not very likely to be effected in ſucceeding ages, may appear from the following particulars. 1ſt, Where is here an inſtance of any ſuch thing, that has been done any where in the world, except in ſuch places, where the conquerors have been more numerous than the conquered? It is known to all, who are acquainted with the ſtate of *Europe*, that in moſt kingdoms there are ſome provinces, which ſpeak a different language from what is ſpoken in the reſt of the provinces of the ſame kingdom. 2dly, Many thouſand Highlanders are ſeparated from the reſt of the nation by iſlands, ſo that they have very little converſation or commerce with any but thoſe of their own language; and therefore it is very hard to imagine, how their language ſhould be extirpated. 3dly, It has not been known or heard of in this age, nor for any thing we can learn in ſome paſt ages, that any one pariſh, where they have been wont to preach in Iriſh, has learned ſo much Engliſh, as not ſtill to need a preacher in the Iriſh language. 4thly, In ſeveral pariſhes in the borders of the *Highlands*, where they preach only in Engliſh, there remain ſtill ſome corners, where the inhabitants go to have their children baptiſed, and to hear ſermons in the adjacent pariſhes, where they preach in Iriſh, becauſe they underſtand not thoſe that preach in Engliſh; which plainly ſhews, that the Engliſh language does not prevail ſo much over the Iriſh, as ſome would make the world believe. 5thly, About one half of the miniſters in the *Highlands* (according to our beſt information) preach only in Iriſh, which ſhews, that there is very little Engliſh underſtood in their pariſhes. And where they preach one half of the day in Engliſh, it is in many places of very little uſe to the generality of the people; of whom ſeveral can buy and ſell in Engliſh, who do not underſtand a ſermon in that language. As to the women and children, ſcarce one in twenty can ſpeak Engliſh throughout the *Highlands*. 6thly, It is very conſiderable, that in *Kintyre* (a country in the *Highlands*) whence the Highlanders were expelled, and where others, who ſpoke Engliſh, were planted in their ſtead, in proceſs of time, by frequent converſation with the neighbouring Highlanders, many of them, inſtead of propagating the Engliſh language, have learned Iriſh; ſo that now they preach once a day in Iriſh in the chief churches of the country. To which might be added, 7thly, That the Highlanders, as much as any people, are very much in love with their own ancient language, and jealous of all deſigns againſt it. After all that hath been ſaid, it doth ſufficiently appear, how little ground there is to think it likely, that the language of two hundred thouſand perſons can be extirpated; for by a moderate computation, there can be no fewer in the *Highlands*, where there are about two hundred pariſhes, which makes above a fifth part of the pariſhes of the whole kingdom: and therefore how neceſſary it is to carry on and encourage this deſign for the further reformation of ſo conſiderable a part of the kingdom. When once the children are provided with Iriſh bibles, and taught to read them, they will be means of inſtructing the families, to which they belong. And beſides the great advantage, which people in general will reap by this charitable work, the miniſters themſelves, and ſtudents in divinity, will thereby receive unſpeakable advantage. It will prevent the miſtakes, which many have been guilty of in tranſlating the holy ſcriptures; and by reading the bible in Iriſh, which will be no hard matter to do, for thoſe who can read Engliſh, this impreſſion being in the Latin character, they will be enabled in an apt and uniform ſtile (becoming ſoon familiar by uſe) with greater advantage to expreſs their thoughts

thoughts in their addreſſes to the people, both in publick and in private. The ſcriptures are the weapons of the Chriſtian warfare; and ſhall we unchriſtianly and unmercifully deprive our brethren of that, which they have ſo great need of in their defence and ſafeguard? How careful has the church been in all ages (except ſince Popery prevailed in the world) to tranſlate the holy bible into the language of all nations, which were converted to Chriſtianity! And, not to mention what was done in other countries, *Bede* tells us, that in this iſland the bible was read in five dialects, then vulgarly uſed, to wit, of the Angles, the Britains, the Scots, the Picts, and the Latins. How juſt a prejudice againſt the Papiſts is their hindering people from reading the holy ſcriptures! They put that light under a buſhel, which God hath appointed to be ſet on a candleſtick.

IV.

Mr. Kirkwood *to Mr.* Boyle.

Honoured Sir, *Aſtwick*, Nov. 5, 1687.

THIS is only to ſhew you, that the biſhop of *Roſs*, with the clergy of his dioceſe ſynodically aſſembled, by one of their number deſires, that thanks may be returned you in the moſt affectionate manner, for that very good work, the making the ſcriptures to be more known, when others have deſign to eclipſe them. The number of the miniſters of that dioceſe are 31. They propoſe this, that if you have ſo many bibles as may ſerve them, each of them one, they are moſt willing to pay for them. As for the catechiſms, they give this account, that the province is ſufficiently furniſhed with them already in the Iriſh tongue. This is all that I have heard of late. I know not whether theſe catechiſms, which they mention, are printed: if it is ſo, they are both tranſlated and printed very lately. I hope to hear ſhortly from other parts of the *Highlands*, where there is ſtill, for ought I know, need of ſuch helps. I ſhall not fail to acquaint you, whenever I hear from thoſe parts. When theſe ten or twelve bibles (which my friend Dr. *Dewvane* told me you intended to give to the Highlanders) are bound, I have deſired a friend of mine to ſend them carefully. If you think fit to ſend ſome dozens more unbound, I ſhall take care, that they be bound in *Scotland*, and diſtributed to the beſt advantage. I have wrote to thoſe, who divide them amongſt the Highlanders, to give them chiefly to ſuch miniſters, whoſe pariſhes are in greateſt want of them, with theſe two conditions: 1ſt, that the miniſters read ſome chapters every Lord's day to the people who never heard a chapter read in their lives; and on other days, when they can have occaſion, as at baptiſms, burials, marriages, *&c.* The 2d is, that the miniſters take care of the bible, as being for the uſe of the pariſh, that it be not alienated from this deſign; ſo that if a miniſter be removed into another pariſh, or die, yet the bible may ſtill be kept and preſerved for the uſe of the ſame pariſh. If there are more bibles than ſerve each pariſh, then ſome may be given to the more numerous and conſiderable families, for the benefit of the children and ſervants, who know not the Engliſh tongue. I thought fit to mention the ſending a good many bibles together, becauſe I hope they may be more uſeful now than before, having heard of the good ſucceſs, which ſome zealous perſons have had in preaching amongſt them of late. As to the number of the pariſhes in the *Highlands*, I believe they are not above 200, if you think fit to ſend ſo many. I doubt not but it would be of ſingular advantage towards your deſign, if you wrote a letter, addreſſed in general to the biſhops and clergy of the *Highlands* of *Scotland*, or to the miniſters of the Goſpel in the churches of the *Highlands* of *Scotland*, wherein might be repreſented to them your deſign in cauſing theſe bibles to be printed, and the deſire you have, that they may contribute their aſſiſtance in making your deſign effectual for the purpoſes of the goſpel. I know your piety and zeal to be attended with ſo much prudence and diſcretion, that you are able to do this in that manner, which will greatly conduce towards the rendering your work, which you have done already, ſo much the more profitable. For the better diſperſing of ſuch a letter (which I very much wiſh) there might be 4 or 500 of them printed: or, if you are not for that, care ſhall be taken to tranſcribe ſeveral of them. I hope you will pardon the freedom I uſe in this matter. If I know how to be ſerviceable to you in any good deſign, you might expect to find me always ready to ſhew you, how much I am,

Honoured Sir,

Your moſt affectionate and moſt humble ſervant,

JAMES KIRKWOOD.

HE, whom I have deſired to take care of the bibles, is called *Oſwald*, a bookbinder, at the *Blue Poſts* in *Air-Street Piccadilly*.

I HAVE wrote to *Scotland*, that if it will do well enough to print the little books in the Engliſh character, as I believe it will (for all who can read the one, as I am informed, can read the other) then they may print as many as they think fit at *Edinburgh*, where they can eaſily find an Highlander to overſee the preſs. This, if it ſucceed, will prevent a great deal of trouble. What expence they are at in printing them, may be ſent by a bill of exchange.

Mr.

V.

Mr. Kirkwood *to Mr.* Boyle.

SIR, *Aſtwick*, Dec. 15, 1687.

YESTERDAY I heard from Mr. *Oſwald* (of whom I wrote to you) that there are 32 bibles ready to be ſent with the firſt occaſion. I have writ to the biſhop of *Roſs* this incloſed, which I thought fit to ſend to you, that if it is not wholly according to your thoughts and deſign (which I have preſumed to gueſs at in this manner) then you may either acquaint me more fully with your mind, or deſire Mr. *Oſwald* to write to the biſhop, unleſs perhaps you may think good to write yourſelf. If you think fit to ſend my letter as it is, be pleaſed to ſeal it up, and let Mr. *Gregg* deliver it to Mr. *Oſwald*, to whom I have written about the bibles, that they may be ſent ſafely to *Scotland*. Since my laſt to you I have heard concerning the Iriſh tranſlation of the prayer-books, *&c.* that they have a great mind, that they be printed in *Scotland*, if it can be got done. I heartily pray for your preſervation, and that God may direct and aſſiſt you in all your ways. I am,

SIR,

Your moſt affectionate and

moſt humble ſervant,

JAMES KIRKWOOD.

VI.

Mr. Kirkwood *to the biſhop of* Roſs.

My Lord, *Aſtwick*, Dec. 14, 1687.

HAVING received a letter from one of my friends in *Scotland*, wherein I was told, that it was your lordſhip's deſire, as alſo of all the clergy of your dioceſe, that thanks might be returned to the excellent Mr. *Boyle*, for his generous and charitable offer of ſome bibles for the uſe of the Highlanders; I did accordingly acquaint him therewith. Since which time he hath been pleaſed to cauſe 200 bibles in the Iriſh tongue to be bound, whereof one is for your lordſhip, and thirty one for the miniſters of your dioceſe. The reſt are for the uſe of other pariſhes of the *Highlands*. I know Mr. *Boyle*'s deſign in cauſing theſe bibles to be printed; and now his beſtowing them freely where they are needful, is, that he may thereby contribute his aſſiſtance towards the propagating the knowledge of the Goſpel of Chriſt Jeſus, that by theſe ſacred writings, they who are in darkneſs, and ignorant of divine things, may be enlightened, and reſcued from ſin and folly. He deſires no other reward for theſe books, but to hear they produce the effect, which he heartily wiſhes and prays for. I doubt not but that your lordſhip will recommend to your clergy ſuch methods, as in Chriſtian prudence you judge may be moſt proper and effectual for promoting ſo good a deſign. Mr. *Boyle* hopes, that the miniſters will read every Lord's day ſome chapters to the people, or cauſe them to be read by fit perſons, at that time, and at other times, when people come to church. Theſe bibles are intended for the uſe of the pariſhes; and therefore you will be pleaſed to acquaint your clergy therewith, leſt otherwiſe by the death of the miniſters the bibles fall into the hands of thoſe, who will not take much care to ſerve this deſign. I am mighty glad, that it hath pleaſed God to raiſe up Mr. *Boyle* to perſue ſo excellent a deſign, as the ſpreading abroad the knowledge of the holy ſcriptures, which he hath done likewiſe in ſome other languages: ſo that he hath not only afforded great light to the world by his excellent philoſophical writings, but, which is far better, hath done his utmoſt to fill ſome of the dark places of the world with the light of divine truth, by theſe uſeful tranſlations of the bible into ſo many languages. How much may ſo great an example make many of our ſacred order to bluſh and be aſhamed, conſidering that we do ſo little good in the world, and concern ourſelves ſo little for the honour of our great maſter; have ſo little love for the ſouls of men, and are ſo barren of good deſigns and works, although we are appointed by God for this very thing, to make it our buſineſs to ſave men's ſouls, to make them wiſe and good, to turn them from darkneſs to light, by the light of pure and holy doctrine, and of an heavenly converſation? And as at all times this ought to be our meat and drink, ſo eſpecially when we ſee how great pains many are at to fill the world with darkneſs, to corrupt men's hearts and lives, to lead them into errors and deluſions. I humbly beg your lordſhip's bleſſing and prayers. I am,

My Lord, *&c.*

JAMES KIRKWOOD.

Mr.

VII.

Mr. Kirkwood *to Mr.* Boyle.

SIR, *Aſtwick*, Dec. 27, 1687.

AFTER a long and tedious expectation, I have at laſt received a letter from the Highland Miniſter, to whom the tranſlation of the ſmall treatiſes was entruſted, giving me an account of his having finiſhed that work, and his having made ſome conſiderable additions for the uſe of the Highlanders. The miniſter's name is Mr. *Kirk*, who is one of very great worth, a learned, pious, zealous man. The tranſlation is at *Edinburgh*. I have wrote to ſome perſons there to take care there be printed about 2000 of them in the Latin character, according to Mr. *Kirk*'s deſire. He tells me, that both miniſters and gentlemen rejoice mightily to think, that there are hopes of their ſeeing the bible with catechiſms and prayer-books in their own language; and that the miniſters are very willing to read the ſcriptures publickly in their churches. He ſays, a great many miniſters and gentlemen would buy the bibles, if they were ſent down, and the price ſet on them; and that 200 might quickly be ſold: but (he adds) the *Highlands* require 2000: and if the bible were reprinted (which he ſays were fit to be done in the Latin character) they could ſell them, and get the money very ſoon. He ſays (which is very juſt) it behoved to be well attended, if there were another edition, by a very ſkilful Iriſhman. He hath remarked ſeveral errata in this edition, one letter for another, and ſome words wanting, which he promiſes to ſend me in a ſheet of paper, if ever there be need of it. He ſays, that generally all people in the *Highlands* are overjoyed with the thoughts of *this*, and are mighty eager to have bibles. He bleſſes the God of heaven and earth, who put *this excellent* deſign into your breaſt, and adds [who knows what a heavenly flame *this* ſpark may kindle?] He adds a great many pious and zealous expreſſions, which I have not at preſent time to tranſcribe. I would have ſent you the letter itſelf, but that it is ſuch as I am unwilling to loſe, and I know not, if *this* ſhall come to your hands. Not many days ſince, I ſent you a letter, with one incloſed to the biſhop of *Roſs*; I know not whether you have received them. Inſtead of this letter, I had a great deſire to have come my ſelf, and talked with you of this affair, but that I am not as yet fit to travel ſo far, eſpecially in this ſeaſon of the year. If you think fit to ſend what bibles you have, if you have 200 remaining, you need not be at the trouble to cauſe them to be bound; they may be ſent in ſheets, with thoſe, which Mr. *Oſwald* hath received for the dioceſe of *Roſs*. If you judge it proper to put any price upon them, let me know, and I ſhall take care, that the money be received at *Edinburgh*, by thoſe, who will ſend it by a bill of exchange faithfully. A part of the price may be employed in printing the little treatiſes. As for the reprinting the 2000, I wiſh it were done. It were a deſign worthy of the concurrence of ſeveral perſons, who have money, charity and zeal together: if there were ſuch an edition of ſo many bibles, I doubt not but the money might be recovered by the ſale of them, if that were needful. For my own part, I would willingly contribute 10 *l.* towards ſuch a work. I cannot but have a great compaſſion for many poor ſouls, which live under a ſad night of ignorance, ſuperſtition, and profaneneſs in thoſe barbarous places. Mr. *Kirk* tells me, he hath drawn up an Iriſh vocabulary, a grammar, and a collection of Iriſh proverbs, which makes him deſirous of a ſmall but competent number of Iriſh types, with the contractions, for which he will ſend money. If you think fit to let him have any of yours, they may be ſent with the bibles, and the price of them (if you let me know it) ſhall be ſent him. He writes of an Iriſh book or two lately printed at *Rome*, which I would buy for him. If you know any Iriſhman at *London*, who deals in books, I make bold to deſire you to cauſe your man, Mr. *Gregg*, to enquire about them, and to buy them for me, that they may be ſent, when other things are ſent. He writes a long account of the reaſon of the great delay in his tranſlation, which is too tedious to tranſcribe. At the ſame time, when I received this letter of Mr. *Kirk*, I received another from the excellent author of the catechiſm and prayer-books, Mr. *Charteris* (formerly profeſſor of theology at *Edinburgh*, but hath lived privately ſince the teſt) who deſires me to ſhew you, that, among many others in *Scotland*, he does highly honour and admire you, for your ingenious and learned labours, and your fervent charity and zeal; and wiſhes, that the lord may long preſerve you, and may ſtir up others to imitate your excellent virtue and piety. I know you value not yourſelf one whit the more, becauſe others do ſo, and therefore I am not afraid to let you know what this excellent perſon did deſire me. I heartily join with my worthy friend in wiſhing, that the Lord may long preſerve you, and that he may direct and aſſiſt you in every good word and work. Whenever I think I may venture upon a journey to *London*, I intend to come and wait upon you. I make bold to deſire you to give my moſt humble ſervice to your excellent ſiſter, my lady *Ranelagh*. I am,

SIR,

Your moſt affectionate

and moſt humble ſervant,

JA. KIRKWOOD.

VIII.

Mr. Boyle *to Mr.* Kirkwood.

Worthy Sir, *London*, March 5, 1687-8.

WHEN I come to look upon the date of your letters, I cannot but be much troubled to find, how long I have been your debtor for an anſwer. And I ſhould be as much aſhamed, as troubled at it, but that it pleaſed God to afflict me with a diſtemper, which, though his goodneſs made very ſupportable to me, yet it has made me ſo weak and tender, that I have not ſtirred out of the houſe theſe two months: during which time I was indiſpoſed to keep a literary correſpondence, even with my near relations; whereto I muſt add, that during a good part of the time, your letter was unhappily miſlaid. The biſhop and preſbytery of *Roſs* put too high a value upon my weak endeavours in a work, that need not expect a retribution from men. But I am very glad to find by their proceedings, how well they reliſh thoſe things, that aim at the propagation of the Goſpel; and I wiſh, that all, that ought to be equally zealous to promote affairs of this kind, would ſhew themſelves equally concerned for the advancement of this. Some paſſages in your letter oblige me to take the freedom to tell you, that I perceive you have not been rightly informed of my circumſtances in reference to the publication of the Iriſh bible. For at firſt my aim was, as I thought it became me, to do ſome ſervice to the country, wherein I was born, and have ſome little eſtate, though I have lived a great ſtranger to it; and eſpecially to contribute to the converſion and the inſtruction of thoſe Iriſh natives, that are moſt of them of the Romiſh religion. In purſuit of this deſign, I, with much ado, procured a verſion of the new teſtament, made, as I remember, in ; and finding it to have been many years out of print, the copies having, as I have been informed, been bought up, from time to time, by ſome Romiſh eccleſiaſtics; I cauſed a font of Iriſh letters to be caſt, and the book to be here reprinted; of which I ſent over ſome hundreds, ready bound, to be diſtributed gratis among thoſe, to whom they ſhould upon the place be judged the moſt likely to do good. Theſe things I relate, that you may not think it ſtrange, that I have not ſtill by me any number of new teſtaments in Iriſh; though I ſhould not have ſo much diſfurniſhed myſelf of them, if I had been then ſo informed, as now I am, that this language is ſtill that of a great part of the North of *Scotland*. And my main deſign being, as I ſaid above, to acquaint the native Iriſh with the divine oracles; as ſoon as I had with the ſame characters cauſed an edition to be made of an Iriſh verſion of the old teſtament, which the excellent biſhop *Bedell* had long ago procured, and which, after the lately mentioned publication of the new teſtament, divers of the reverend Proteſtant clergy in *Ireland*, beſides ſome worthy prelates, intended to promote, but by various occurrences were hindered from accompliſhing their good deſires; as ſoon, I ſay, as the preſs had diſpatched this book, I ſent a competent number of theſe books into *Ireland*, to be diſtributed gratis by ſome pious and judicious perſons there. By all which particulars you may eaſily diſcern, that it was not, nor well could be, my principal deſign, to provide for the Highlanders and other natives in *Scotland*, that ſpeak *Iriſh*; and that it never was my purpoſe, that any of thoſe, that were printed at my charge, ſhould be ſet to ſale. But yet becauſe it were great pity, that the pious intentions and endeavours of your reverend miniſters ſhould be altogether diſappointed, I ſhall acquaint you with what comes into my mind about it. Before I well knew the great extent of the Iriſh language in *Scotland*, I had cauſed ſeveral old teſtaments to be bound for the uſe of your nation, divers of which remain yet in my hands. So that as to the one and thirty you mention, I can ſpare each of them a book, which I think you very diſcreetly adviſe, ſhould not be diſpoſed of by the miniſter at his death, or removed, but be kept for the uſe of the pariſh. And theſe will be accompanied with one with a gilt back, to be preſented to the right reverend biſhop of *Roſs*; which I hope his lordſhip will accept, as an acknowledgment of my juſt ſenſe of his pious forwardneſs to promote the good work I aimed at. I ſhall alſo ſend an hundred more unbound, ſince you deſire to have them ſo, which, with the other thirty two, ought to be diſpoſed of gratis to ſuch pariſhes as my lord biſhop, who I perceive conſults with his preſbytery, ſhall think fit. With Iriſh new teſtaments I formerly told you, that I was not furniſhed. And I did not think fit to reprint them with the old, not only becauſe it was judged needleſs; but becauſe it was ſcarce poſſible to bind them together, without making the volume much too bulky and unwieldy. But having, upon the late peruſal of your letters, cauſed enquiry to be made, I am informed, that a bookſeller, having with my leave printed a ſomewhat greater number of new teſtaments than I had contracted for, he has yet in his hands about fifty old teſtaments, and about one hundred and fifty new ones. He can afford each whole bible for a mark, provided the whole fifty be taken off his hands; and for the ſupernumerary hundred, or thereabouts, of new teſtaments, he can part with them at three ſhillings a piece in quires.

IX.

Preſbytery of Roſs *to Mr.* Kirkwood.

Reverend brother, Canonry of *Roſs*, Oct. 15, 1688.

WE the preſbyters of the dioceſe of *Roſs* being this day ſynodically convened, our right reverend biſhop cauſed read publickly a letter from you to his lordſhip, dated June laſt; wherein, to our great ſatisfaction, we heard an account of the pious endeavours of the honourable and excellent Mr. *Boyle*, and were ſurpriſed with the bountiful offer you were pleaſed in his name to make, of a bible and conſiderable number of catechiſms tranſlated into the Iriſh language, for every pariſh within this dioceſe: for which we can return nothing more ſuitable, than our moſt hearty thanks to the excellent and famous Mr. *Boyle*, and our humble prayer, that God may reward himſelf, and bleſs all thoſe his good deſigns, for the benefit of mankind, and withal to return you alſo our thanks for repreſenting to him our need and deſires for theſe books. We ſhall uſe our utmoſt endeavours to proſecute all his religious deſigns, by following thoſe methods, which he by you recommends as far as the circumſtances of our people can allow; for ſo our reverend biſhop has, with a great deal of affection and reſpect to that worthy perſon, very earneſtly laid upon us. We are alſo uſing all diligence to get that noble preſent of books brought among us; but the diſtance of the place, the unuſual ſtormineſs of the weather, and the confuſions, that we are all put into by the march of our pariſhioners, who are commanded to repair unto the King's hoſt, under the ſevere penalties of the law, makes us hopeleſs to get them brought to this place, for ſome time, till it pleaſes God to calm things, as well as the weather. But the zeal we have to enjoy the benefit of them will not ſuffer us to be negligent about them. In the mean time, we ſhall be moſt ready to do all ſervices, that are in our power, to the generous Mr. *Boyle*, and to you, to whom alſo we think ourſelves much obliged, and ſhall never ceaſe to remember you both in our prayers; for we are, and ſubſcribe ourſelves by the clerk of the meeting,

Reverend brother,

Your affectionate brethren to ſerve you,

James Roſs, Cl. Synod.

X.

Mr. Kirkwood *to Mr.* Boyle.

SIR, July 13, 1689.

I SHOULD have waited upon you before I went out of town, but I have been obliged to be with a perſon, who had the ſmall-pox, and is now dead of them; which makes me, that I do not come to wait upon you myſelf, knowing, that you have never had that diſeaſe. As for what you mentioned to me, when I was laſt with you, about giving ſome more bibles to the Highlanders, I have conſidered of it with Mr. *Kirk*, and other diſcreet perſons, who do not think it neceſſary, at this time, ſince each pariſh hath a bible already ſent to them, or deſigned for them; and as for others, this impreſſion I hope will be ſufficient for them, for ſome time. We cannot but be more and more ſenſible of your generous charity, for which God will reward you. As for the new teſtaments, which are not yet diſtributed, if you pleaſe to beſtow of them upon the pariſhes, which are largeſt, and have greateſt need of them, it will be a very great and excellent preſent to thoſe poor people. Mr. *Everingham* ſays, he thinks he has but about thirty new teſtaments belonging to you. If you think fit to beſtow them, they may be ſent with the bibles, which are now a printing, when Mr. *Kirk* returns to *Scotland*. As for the binding of them, we ſhall take care, that it be done, without putting you to any more charge, which hath already been very extraordinary. Mr. *Everingham* tells us, that he is obliged to make uſe of two of your Iriſh bibles, which are neceſſary in correcting; which I know you will be very well ſatisfied with. I heartily wiſh you health and all ſort of happineſs. I hope God will, in his good time, reſcue *Ireland* from the hands of wicked men. I am,

SIR,

Your moſt affectionate

and moſt humble ſervant,

James Kirkwood.

Mr.

XI.

Mr. Spalding *to Mr.* Boyle.

SIR, *Edinburgh*, June 28, 1690.

I AM appointed by the general meeting of the miniſters and elders of this church, as to ſhew the ſenſe they have of your great pains in cauſing emit the bible in the Iriſh language, ſo to deſire, that theſe two hundred Iriſh bibles already at *Edinburgh* may be at the diſpoſal of the next general aſſembly of this church, to be held on the third thurſday of October next; and that they may not be diſperſed, until the ſaid general aſſembly order the viewing of the tranſlation, and their being made uſe of publickly in congregations. This is deſired of you, in the name and by the appointment of the ſaid general meeting, by,

SIR,

Your honour's very humble ſervant, and their clerk,

Jo. Spalding.

DIRECT your return, *To* Thomas Edgar, *chirurgeon, at his ſhop, over-againſt the Croſs, on the north ſide of the ſtreet*, Edinburgh; *for Mr.* John Spalding, *miniſter at* Kirkcudbright.

XII.

Mr. Boyle *to* Mr. Kirkwood.

SIR, *London*, October 18, 1690.

I CONFESS you have exerciſed a great deal of charity (which yet I ſhall not be ſurpriſed to find in you) if you have not cenſured me in your thoughts, for my not having ſent you all this while an acknowledgment of your obliging letter, and the valuable preſent that accompanied it. But though my ſiſter and I were juſtly ſatisfied with the good counſel and reflections contained in your pious and ſeaſonable book; yet, when I ſhould have returned you my thanks for it, in an anſwer to your letter, I found the care I intended to take of it had not kept it from miſcarrying, as, after a fruitleſs ſearch, I preſumed it had done. But on the laſt Lord's-day, turning over ſome papers, for which I had a peculiar regard, I happily lighted on that, which I had ſo long miſſed. I need make no return to what you are pleaſed to ſay to my advantage and your own diminution, ſave that I look upon the former as a compliment, and the latter as a dictate of modeſty. But I am altogether of your mind, of what you write about the education of youth; for I think the rectifying of that to be a thing ſo important, that, till it pleaſe God to awaken men to a greater ſenſe than they yet have of the neceſſity and uſefulneſs of that, I ſhall ſcarce expect any ſuch reformation as I wiſh, either of men's principles, or their manners. And I think it as much the intereſt, as duty, of thoſe, whom it concerns, to liſten to the good advices you give them in your ſerious diſcourſe. Not long after I received the favour of your letter, there came to my hands, out of *Scotland*, a ſhort one (of a long date) from an unknown writer; to whom, becauſe he was ſo, I did not think fit to return an anſwer, till I had conſulted you about the contents. And during the time I could not find your letter, the other, that I thought I had carefully put up, was unhappily miſlaid too. For which reaſon, I muſt beg you to aſſiſt me to apologize for the delay occaſioned by that unlucky accident. But now, having recovered both your's and your countryman's, I muſt deſire your thoughts, what will be fit for me to do upon the latter, whereof a copy is incloſed to you, by,

Sir, your's, *&c.*

Robert Boyle.

XIII.

Mr. Kirkwood *to Mr.* Boyle.

SIR, *Aſtwick*, October 30, 1690.

YESTERNIGHT I received your very kind and obliging letter, for which I return you my moſt humble thanks. I am glad, that the little plain treatiſe I made bold to ſend you, has met with your approbation. This is the effect of your goodneſs and charity, and of your zeal for any thing, that ſeems to tend to the honour of our great maſter, who accepts of poor and weak endeavours, if they are ſincere.

As to the affair of the bibles, I have not been unmindful of it. I have writ to ſeveral perſons to do what they can to render the deſign effectual; particularly I have writ to one of the miniſters of *Edinburgh*, Mr. *David Blair*, who correſponds with me at preſent about promoting that good work. In my letters to him (the laſt whereof was writ about a month ago) I gave

him an account of the bibles and catechiſms you ſent to *Edinburgh*; I ſhewed him how your great charity, in cauſing ſo many bibles to be printed, and your beſtowing 200 of them upon the *Highlands* of *Scotland*, has encouraged ſeveral pious and charitable perſons, chiefly of this kingdom, to give very liberally towards printing 3000 more bibles and 1000 teſtaments, whereof the teſtaments are already bound, as alſo about 2000 of the bibles. I acquainted him likewiſe, that you have been at the charge of printing 3000 catechiſms, beſides the firſt 3000. I deſired him therefore, earneſtly to recommend this buſineſs to the general aſſembly, that they might think of the way, how to tranſport into *Scotland* the bibles, teſtaments and catechiſms, which are now ready at *London*; and to conſider how to diſtribute into the *Highlands* both the books you have given, and ſo many of the reſt of the books, as at preſent are neceſſary to be diſtributed amongſt the *Highlanders*. The great thing, which I deſired him to recommend to the general aſſembly, was, the ſettling of ſchools in every pariſh of the *Highlands*, that the children may be taught to read, and to make uſe of the catechiſms and bibles; by which means they may prove happy means of propagating the knowledge of God in the families, to which they belong. Thoſe things I have likewiſe recommended to ſome other miniſters, who, I hope, have been careful to act their part faithfully in promoting this deſign in their general aſſembly. It is likely the miniſters will deſire the concurrence of the parliament in a matter of ſo great importance, which tends ſo much to the benefit both of church and ſtate. I wrote lately to Dr. *Horneck* to propoſe it, by ſome fit perſon, to the King, that he would recommend the encouragement of this deſign to the parliament of *Scotland*, that they may promote it ſo far as they can at this time. I have heard ſince from the doctor, who approves the thing. There ſeems a great deal of reaſon, that the King ſhould appear in a matter, which is ſo much for the honour of the great King. And though the preſent confuſions in the *Highlands* do not permit to do all that we wiſh, yet ſomewhat may be done and projected, till there be an opportunity to do more.

I THOUGHT it would not be improper, in anſwer to ſome part of your letter, to give you this general account of the affair.

You are pleaſed to deſire my thoughts what to do as to Mr. *Spalding*'s letter. It is your humility to propoſe this. Though I am not fit to give advice to a perſon of your wiſdom, yet, in obedience to your commands, as a well-wiſher to the deſign, I ſhall give you my thoughts. If you yourſelf judge it convenient to write, it ſeems not amiſs, in my humble opinion, to ſignify to Mr. *Spalding* your being deſirous, that they, whom he mentions in his letter, would think of fit ways to diſtribute, and to render uſeful the bibles and catechiſms you have beſtowed for the uſe of the *Highlanders*; and that you and a great many more would be very glad to hear of their zealous endeavours to reſcue ſo great a part of the nation from that ſad ſtate of ignorance and barbarity, in which you hear they are. This, when ſuggeſted by you, may prove no ſmall ſpur to them. I know the principle of divine charity, which moved you at firſt to attempt the impreſſion of the bible in Iriſh, will move you to do any thing you think will tend to render what you have done ſucceſsful and effectual.

WHEN Mr. *Kirk* went to *Scotland*, I wrote to the perſon, with whom your bibles, *&c.* are depoſited, not to give any more of them to any body, but to leave it wholly to the enſuing general aſſembly, to order the diſpoſal of them, according to your intention and deſign; of which I wrote fully to Mr. *Blair*, from whom I expect to hear very ſhortly what the general aſſembly has done in this important affair. I have nothing elſe to add, but my hearty prayers for your ſafety and preſervation. I am,

SIR,

Your moſt obliged and moſt affectionate humble ſervant,

JAMES KIRKWOOD.

XIV.

Biſhop of Roſs *to Mr.* Kirkwood.

Reverend Sir,

I HAD the favour of your diſcreet and obliging letter, dated June the 16th, upon the 24th of Auguſt. You muſt not think it was the fault of your correſpondent, that it came not ſooner to my hand, but the diſtance of the place from *Edinburgh*, and the uncertainty of a ſure bearer. However I thought myſelf extremely obliged by your letter; not only becauſe it gave me an account of the labours of that honourable and excellent perſon, Mr. *Boyle*, but becauſe it gave me alſo an opportunity of a new converſation (at leaſt by letters) with ſo worthy a perſon as yourſelf. I have cauſed tranſcribe your letter, and am to ſend a double thereof to every biſhop any ways concerned with people in his dioceſe, that ſpeak Iriſh; judging, that it would better ſpeak forth the learned Mr. *Boyle*'s mind and your's, than any thing I could ſay; and if I cannot get theſe books brought hither before the meeting of my ſynod, I ſhall with them adviſe of the beſt way of doing it. I ſhall alſo recommend to my brethren, and do what is in my power, to proſecute the religious deſign of the author of ſo great a favour as you narrated; though I am much of your mind, that not a few even of the

preſbyters muſt begin at the alphabet, that they may but read the Iriſh language in its proper character, there being ſo few books in that language and character paſſing in all this country; and we are removed at ſo great a diſtance from *Ireland* and the *Weſt-Iſles*, that it will oblige the preſbyters to paraphraſe many words in the Iriſh bible before they be underſtood fully by their people: ſo that I cannot condemn the deſigns of ſome, to have that language quite worn out of this country; and if with it we could alſo put away the barbarity of the manners of ſome of our Highlanders, I ſhould think it a very good work. I took care, a conſiderable while ago, to cauſe ſome of the preſbyters, who were beſt ſkilled in that language, to tranſlate into Iriſh a catechiſm, which is appointed to be made uſe of in all the dioceſe either in Engliſh or Iriſh, according to the capacities of the perſons to be catechiſed, as it is alſo in ſome other dioceſes; and in my opinion, it ſerves the ends of catechizing better than that of the aſſembly. I ſend you herewith a double of it in the Engliſh, that at your conveniency I may have your opinion about it, and, if it be poſſible, the judicious ſentiments alſo of the pious Mr. *Boyle*. Care alſo was taken, that there be ſchools for teaching the youth to read in every pariſh; but I confeſs hitherto it has only been in the Engliſh language: and no leſs care is taken, that every miniſter read a portion of holy ſcripture; and in places, where moſt of the people underſtand only the Iriſh, he is at the pains to tranſlate it into that language, for which this noble preſent of the Iriſh bible will be very uſeful to them, becauſe I have heard ſome of them complain, that they could not get words to expreſs in Iriſh ſome paſſages of holy writ. I cannot but with you regret, that ſo few intend ſo good and catholick deſign as the worthy Mr. *Boyle* does; but this adds the greater luſtre to his fame. We have many excellent treatiſes written of late by the worthy guides and paſtors of the church of *England*, and ſome alſo by learned and pious laicks; all which are very uſeful for aſſerting and improving our holy religion, for which we are extremely obliged to them: but if in this poor church and nation we make fewer publick appearances, you are better acquainted with the reaſons of it, than that you need be told them by me. I ſhould think all was well enough with us, if we could truly uſe the ancient motto, *non magna loquimur, ſed vivimus*; but that I do not weary you in my firſt letters, I ſhall only ſay, that I have ſeen moſt of the judicious writings of the learned Mr. *Boyle*; and they have raiſed in me, as I think they muſt do in all others, an high but juſt eſteem of him; and for this laſt bounty, by which he has obliged all my charge and me, I know his pious generoſity expects no other reward but our prayers for him, wherein ſhould we be wanting, we were much to blame before God and man. Nor can I cloſe before I return you my own hearty thanks, as well as thoſe of ſuch in theſe bounds, as I have ſpoken with, for your kindneſs in this affair to us all, and in your letter to myſelf. When my brethren meet with me in the ſynod, it is like they will expreſs their own ſenſe of it. Wherefore, intreating, that you may upon occaſion let me know of the health and other good works of Mr. *Boyle*, and what way I can beſt ſerve him or you, I heartily commend you to the grace of God, and beg your prayers for,

Reverend Sir,

Yours, *&c.*

J. Rossen.

NUMBER V.

Letters from Mr. *John Eliot* of *New-England* to Mr. *Boyle*, relating to the ſervices of the latter for the propagation of the Goſpel in *America*. *Life*, p. 87.

I.

Right honourable, *Roxburg*, Sept. 30, 1670.

YOUR conſtant care of, and ſteadfaſt affection unto this Indian work (which the Lord hath in great undeſerved mercy to me, put under my hand, a weak and unworthy inſtrument therein) do greatly oblige my heart to honour you, and pray, that it may be remembered by the Lord in that great day, when he will ſay [*come ye bleſſed*] unto all the ſincere benefactors unto his people. You have alſo added no ſmall encouragement unto me, in that worthy gift, which your honour is pleaſed to beſtow upon me, *viz.* *Pool's Synopſis*, or *critica ſacra* upon the whole bible, which, though it be not yet come, is under the care and faithful hand of my worthy and true friend Mr. *Aſhurſt*; for which deſirable gift, I return unto your honour my humble thanks. Touching the preſent ſtate of this work with the Indians, I have written to our worſhipful commiſſioners, who will ſend it unto your honour, governor of the honourable corporation; and therefore I ſhall keep ſilence of that matter here. And whereas your honour will ſee, that I have undertaken and begun a kind of academical reading unto them, in their own language, thereby to teach the teachers and rulers, and all that are deſirous of

learning. I find, by experience, that it will be very neceſſary to have ſome entertainment of food, for all the principal men at leaſt, which do come; for many are to come a great way, and had we but food to entertain them when they come there, it would be ſome encouragement. And I have ſome thoughts, if God give life and means, to read medicine, and call for ſuch roots (for they altogether uſe the root, and not the herb) as they have experience of; eſpecially had I wherewith to recompenſe any, that bring in a deſirable experiment. There hath been a rare work of God this ſummer in a great pond at *Watertown*, where all the fiſh died, and were not willing to die in the waters, but as many as could thruſt themſelves on ſhore, and there died; not leſs than twenty cart load, by eſtimation, lying dead, all at once, round about the pond. An eel was found alive in the ſandy border of the pond, and being caſt into the water, ſhe wriggled out again, as faſt as ſhe could, and died on the ſhore. An inhabitant of the town, living by the pond, his cattle uſe daily to drink there; but then, for three days together, they refuſed there to drink; but after three days, they drank of the pond, as they were wont to do. When the fiſh began to come aſhore, before they died, many were taken and eaten, both by Engliſh and Indians, without any hurt; and the fiſh were very good. Now the diſeaſe of the ſtone groweth frequent among the Engliſh, and beginneth among the Indians; which ſtirreth me to ſearch, and I clearly find, that a crude ſtomach provides the matter, and cold in and about the bladder and ureters is the efficient of the ſtone, eſpecially in thoſe, whom I have converſed with, as may be demonſtrated. But I am over bold to preſume to meddle ſo far unto your honour. I therefore ſhall ceaſe to give you any further trouble at preſent. So committing you to the Lord, and to the word of his grace, I remain

Your honour's to ſerve you in the ſervice of the Lord Jeſus,

John Eliot.

II.

Right honourable nurſing fathers, *Roxburg*, October 23, 1677.

THE poor praying Indians do thankfully acknowledge, that (under God our heavenly father, and under Jeſus Chriſt our redeemer, who redeemeth us out of all our troubles) you have been the means and inſtruments in his hand, to ſave and deliver us. God moved your hearts to own us, in that black day, when all were againſt us, and we were almoſt ready to be ſwallowed up in deſtruction; which dark time we ought not to forget, nor your owning kindneſs unto us in that dark day.

AND ſince that, your charity hath greatly revived and refreſhed us. Many of our aged, decrepid, fatherleſs, and widows, ſtill wear the garments, not yet worn out, which your charity did, the laſt winter, clothe us withal. And although we yet know not what our honoured commiſſioners will do for us, whoſe favour we doubt not of; yet underſtanding, that ſome doubt is raiſed about your countenancing and encouraging our rulers, who are of us, and live among us, and, without whoſe preſence and aſſiſtance, the Lord's work of ſoul-inſtruction and edification will ſoon faint, ſink, and come to nothing; our humble petition is, firſt to God, that he, who hath hitherunto, would ſtill move your hearts for our good and welfare; and next, our petition is unto yourſelves, that we may have the countenance of your favour, to countenance and own our rulers among us, without whoſe countenance, our teachers will be of little power, eſpecially among our youth and riſing generations, who do not yet ſavour the things of the Goſpel of Jeſus Chriſt; and among ſtrangers, who have not yet taſted how good the Lord is, though for their protection and ſafety they have crouded in upon us.

NOBLE hearted Sir, your gift I do ſtill religiouſly keep, for ſome ſpecial and eminent ſervice of the Lord, in the Lord's time. In our firſt war with the Indians, God pleaſed to ſhew us the vanity of our military ſkill, in managing our arms, after the European mode. Now we are glad to learn the ſkulking way of war. And what God's end is, in teaching us ſuch a way of diſcipline, I know not. By our late eaſtern war it hath pleaſed God to ſhew us our weakneſs by ſea, as formerly by land. The Indians took many of our fiſhing veſſels, and the men that belonged to them, and forced them to ſail whither they deſired: many of the men delivered themſelves and their veſſels; many Indians were ſlain, ſome Engliſh. The hiſtory of theſe actions I have not: others do attend that ſervice, to whom I leave it. The governor of *New-York* ſent a ſtrength this ſummer, and took poſſeſſion of a northern port, where they fixed and fortified themſelves: ſince whoſe coming thither, the Indians have not ſtirred much. Little action hath paſſed, but I hear not of any peace made. The Yorkers have taken in hand a chargeable deſign: what profit will come of it, I know not; time will diſcover that: whether their intention be to promote religion, or only trading, I know not. It pleaſed the Lord, very lately to permit a ſmall handful (not twenty) of the late ſcattered rod to make a ſore direption upon *Hatfield* and *Dearfield*, at *Conecticot*; where about twelve perſons were killed, more than twenty carried away captive, or loſt; ſeven dwellings burned, and ſundry barns full of corn; and ſince they have appeared at *Hadly*, burned the mill. They had parly with them, treated about reſtoring the captives, agreed of a time and place of meeting; but the Indians failed to appear. Theſe laſt actions have very much diſcouraged our people from repairing the deſtroyed towns, which ſome were beginning to

do.

do. We had a Sachem of the greateſt blood in the country, ſubmitted to pray to God, a little before the wars: his name is *Wanalaunſet:* in the time of the wars he fled, by reaſon of the wicked actings of ſome Engliſh youth, who cauſeleſsly and baſely killed and wounded ſome of them. He was perſuaded to come in again. But the Engliſh having ploughed and ſown with rye all their lands, they had but little corn to ſubſiſt by. A party of French Indians (of whom ſome were of the kindred of this Sachem's wife) very lately fell upon this people, being but few and unarmed, and partly by perſuaſion, partly per force, carried them all away. One, with his wife, child, and kinſwoman, who were of our praying Indians, made their eſcape, came in to the Engliſh, and diſcovered what was done. Theſe things keep ſome in a continual diſguſt and jealouſy of all the Indians. I ſhall give your honour no farther trouble at preſent. We intreat your prayers, and commit you to the Lord, and reſt

Your honour's to ſerve you in the Lord Jeſus,

John Eliot.

III.

Roxburg, Nov. 4, 1680.

Right honourable, charitable, indefatigable, nurſing father,

WHEN good works of pure charity are ſown three hundred fold thick, and that by a living hand, Lord what a reaping time or harveſt will there be! Sir, you are eminently mindful of that Goſpel charge, 1 *Tim.* vi. 17, 18, 19. *Charge them, that be rich in this world, that they be not high minded, nor truſt in uncertain riches, but in the living God, who giveth us richly all things to enjoy.* That they do good, that they be rich in good works, ready to diſtribute, willing to communicate, laying up in ſtore for themſelves a good foundation againſt the time to come; a foundation not of grace unto juſtification, by way of merit, but a foundation of degrees of glorification, when God will in free mercy diſtribute his gifts of glory, according to our improvements of our talents in the exerciſe of grace: he that gained ten talents, ſhall have ten cities.

I KNOW it will pleaſe your charitable heart to hear how it fareth with thoſe, that are your alumni. We are in great affliction by the Manquaoy Indians: more than 60 at ſeveral times have been killed or captived; a narrative whereof major *Gookins* preſented to lord *Culpepper*, who was affected with it. Alſo he preſented a copy thereof to Sir *Edmond Andros*, who was likewiſe affected with it, though it is ſaid, that he might have prevented it. We hope he will move in it, and our Mr. *Pinchon* is gone up to join with Sir *Edmond* to endeavour a peace. Major *Gookins* intendeth to preſent your honour with a copy of the ſame narrative. The Eaſtern Indians do offer to renew peace with us, and to ſubmit themſelves to be taught to pray unto God. A chief Sachem was here about it, a man of a grave and a diſcreet countenance. Our praying Indians, both in the iſlands, and on the main, are (conſidered together) numerous; thouſands of ſouls, of whom ſome true believers, ſome learners, and ſome are ſtill infant; and all of them beg, cry, intreat for bibles, having already enjoyed that bleſſing, but now are in great want. Your honour's liberality in Engliſh bibles is a great favour, which we all with thankfulneſs receive; but the bible in their own tongue muſt help them to underſtand it. We are at the 19th chapter of the Acts; and when we have impreſſed the new teſtament, our commiſſioners approve of my preparing and impreſſing alſo the old. Your honour's bounty of 30*l.* towards our ſending the Goſpel to thoſe remote Indians, that ſpeak the language, whereinto the bible is tranſlated, I do religiouſly keep it, to be improved to the ſame end, to which your honour gave it, of which ſervice I am ſtill in hope, having more intelligence, that there is ſuch a people.

BUT by the immaturity of ſome occurrences, and the intentions of the ſhip's ſpeedy ſailing, I cannot give your honour any further diverſion at this time: intreating your prayers, I commit you to God, and reſt,

Your honour's to ſerve you in any ſervice of Jeſus Chriſt,

John Eliot.

IV.

Roxburg, March 15, 1682-3.

Right honourable, charitable, nurſing father,

THIS winter the worſhipful Mr. *Stoughton* (commiſſioner) delivered to major *Gookins* (a pillar in our Indian work) and to me, the ſum of 6*l.* as the product of your honour's gift of charity; which we did diligently diſtribute to Chriſtian Indians, two aged blind women, others lame in their limbs, others decrepid with age; all which do bleſs you, the giver, and do praiſe God the fountain; and we, your diſpenſers of ſo great charity, do thankfully accept of ſo good an office, as to be the diſpoſers of ſo charitable gifts unto the poor ſervants of Jeſus Chriſt.

THE Lord's work ſtill goeth on among them, and though many of the younger ſort, ſince the wars (where their ſouls received a wound) have declined, and too much miſcarried, yet

now (through the grace of Chriſt) they are on the repenting and recovering hand; of which your honour may hear more, when the work is proſecuted, and brought unto a good effect.

THE great work, that I travel about, is, the printing the old teſtament, that they may have the whole bible. They have had the whole, in the firſt impreſſion, and ſome of the old they ſtill have, and know the worth and uſe of it; and therefore they are importunately deſirous of the whole. I deſire to ſee it done before I die, and I am ſo deep in years, that I cannot expect to live long: beſides, we have but one man (*viz.* the Indian printer) that is able to compoſe the ſheets, and correct the preſs, with underſtanding. For ſuch reaſons, ſo ſoon as I received the ſum of near 40 *l.* for the bible work, I preſently ſet the work on foot; and one tenth part, or near is done: we are in *Leviticus*. I have added ſome part of my ſalary to keep up the work, and many more things I might add, as reaſons of my urgency in this matter. Touching thoſe remote Indians, to the North-Weſt, whoſe language agreeth with ours, ſo that they and we can ſpeak to each other's underſtanding, we have not, as yet, ſo full intelligence of them, as to make a report thereof. But I do both pray and wait for ſome information that way. And for the furtherance thereof, I do carefully reſerve your honour's gift of 30 *l.* to be improved in that ſervice, when the Lord ſhall pleaſe to open a door thereunto. The Manquaoy Indians have not ſtirred to fall upon us this laſt year; but we are not yet fully ſettled in peace, becauſe they declare the Eaſtern Indians to be their enemies; and the way unto them is thorough us; and our Wameſet Indians, who are our moſt northerly plantation, are in danger to be their thoroughfair. And this putteth us into many fears; but our hope and help is in God, our eyes are unto him; this world is a place and ſtate, wherein God's people muſt expect nothing ſtedfaſt, all things mutable and afflicting. But I ſhall ceaſe to give your honour any farther trouble at preſent; therefore, commending you to the Lord, and to the word of his grace, I reſt

Your honour's to ſerve you in Chriſt Jeſus,

John Eliot.

V.

Boſton, June 21, 1683.

Right honourable nurſing father,

YOUR hungry alumns do ſtill cry unto your honour for the milk of the word in the whole book of God, and for the bread of life, which they have fed upon in the whole bible, and are very thankful for what they have, and importunately deſirous to enjoy the whole book of God. It is the greateſt charity in the world to provide for their ſouls. Should your honour pleaſe but to change the object of your bountiful charity, from their bodies to their ſouls, here is enough already ſent over to accompliſh the work; they only ſtay for that word from your honour, *fiat*. My age makes me importunate. I ſhall depart joyfully, may I but leave the bible among them, for it is the word of life; and there be ſome godly ſouls among them, that live thereby. The work is under great incumberments and diſcouragements. My heart hath much ado to hold up my head; but doth daily drive me to Chriſt; and I tell the Lord, that it his word, and your hearts are in his hand. I do therefore commit the whole to the Lord, and leave both it and myſelf to the Lord, who hath not left me wholly deſtitute. But I ſhall give your honour at preſent no farther trouble, for I am ſurpriſed with this opportunity of writing: therefore, committing your honour to the Lord, I reſt,

Your honour's to ſerve you in the Lord,

John Eliot.

VI.

Roxburg, November, 27, 1683.

Right honourable, right charitable, and indefatigable, nurſing father,

ALTHOUGH my haſty venturing to begin the impreſſion of the old teſtament before I had your honour's (*fiat*) may have moved (as ſome intimate) ſome diſguſt, yet I ſee that your love, bounty and charity, doth ſtill breath out encouragement unto the work, by ſupplies of 460 *l.* unto the work, for which I do return my humble thankfulneſs to your honour, and take boldneſs to intreat favour for two requeſts.

FIRST, I pray, that you would pleaſe to accept an apology for my haſte. I am deep in years, and ſundry ſay, if I do not procure it printed while I live, it is not within the proſpect of human reaſon, whether ever, or when, or how, it may be accompliſhed. It is Chriſt's work, and for the good of ſouls, which is my charge to attend, and run adventures to accompliſh, eſpecially when divine providence brought into my hand ſome ſmall encouragement to begin. But if this apology be ſhort (though capable of much inlargement) yet then,

MY ſecond humble requeſt is, that you would pleaſe to draw a curtain of love over all my failures, becauſe love will cover a multitude of tranſgreſſions. The work goeth on now, with

more comfort, though we have had many impediments, partly by ſickneſs of the workmen, for it is a very ſickly and mortal time with us, as alſo the rigour of the winter doth now obſtruct us. The work goeth on, I praiſe God; the ſabbath is ſanctified in many places, and they have ſtill fragments of their old bibles, which they make conſtant uſe of.

I DESIRE to take boldneſs to propoſe a requeſt. A veſſel carried away a great number of our ſurpriſed Indians, in the times of our wars, to ſell them for ſlaves; but the nations, whither he went, would not buy them. Finally, he left them at *Tangier*; there they be, ſo many as live, or are born there. An Engliſhman, a maſon, came thence to *Boſton*, he told me, they deſired I would uſe ſome means for their return home. I know not what to do in it; but now it is in my heart to move your honour, ſo to mediate, that they may have leave to get home, either from thence hither, or from thence to *England*, and ſo to get home. If the Lord ſhall pleaſe to move your charitable heart herein, I ſhall be obliged in great thankfulneſs, and am perſuaded, that Chriſt will, at the great day, reckon it among your deeds of charity, done unto them, for his name's ſake. But I ſhall give your honour no farther trouble at preſent. I humbly requeſt your prayers for me. So, commending you to the Lord, and to the word of his grace, I reſt,

Your honour's to ſerve you in our Lord Jeſus,

John Eliot.

VII.

Roxburg, April 22, 1684.

Right honourable and indefatigable benefactors,

THIS laſt gift of 400 *l.* for the reimpreſſion of the Indian bible doth ſet a diadem of beauty upon all your former acts of pious charity, and commandeth us to return unto your honours all thankful acknowledgments, according to our abilities. It pleaſed the worſhipful Mr. *Stoughton*, to give me an intimation, that your honours deſired to know the particular preſent eſtate of the praying Indians; and alſo, when *Moſes*'s pentateuch is printed, to have ſome copies ſent over, to evidence the real and good progreſs of the work.

YOUR honours intimation hath the force of a command upon me, and therefore I ſhall briefly relate the religious walking and ways of the praying Indians. They do diligently obſerve and keep the ſabbath, in all the places of their public meetings to worſhip God. The example of the Engliſh churches, and the authority of the Engliſh laws, which major *Gookins* doth declare unto them, together with ſuch mulcts, as are inflicted upon tranſgreſſors; as alſo and eſpecially, the clear and expreſs command of God, which they and their children learn and rehearſe daily in their catechiſms; theſe all together have fully poſſeſſed and convinced them of their duty, to keep holy the ſabbath day. So that the ſanctifying of the ſabbath is a great and eminent part of their religion. And though ſome of the vain and carnal ſort among them are not ſo girt to it, as were to be deſired, yet the grave and religious ſort do conſtantly worſhip God, every ſabbath day, both morning and evening, as the Engliſh do.

THE acts of worſhip, which they perform in their public meetings, are as followeth.

THE officer beginneth with prayer, and prayeth for all men, rulers, miniſters, people, young, old, ſick, well, Engliſh or Indians, *&c.* according to that word, 1 *Tim.* ii. 12. *I will that firſt of all prayers be made*, &c. I ſay, the officer beginneth with prayer, *viz.* where they have an officer ordained, as it is almoſt in all the churches. But we have more public aſſemblies, that meet every Lord's day, to worſhip God, than we have churches. There is not yet a church gathered in every place, where they meet to worſhip God and keep the ſabbath; but where it is ſo, they chuſe ſome able godly man (the beſt they can) to manage the worſhip among them: him they call their teacher, and he beginneth with prayer, *&c.* When prayer is ended, they call forth ſuch as are to anſwer the catechiſm; and though this is ſometimes omitted in ſome places, yet that is the way they walk in, and it is often practiſed. When catechiſm is ended, a chapter is read, ſometimes in the old teſtament, and ſometimes in the new; and ſundry of the young men are trained up, and called forth to this ſervice, ſometimes one, ſometimes another.

WHEN the chapter is read, a pſalm is ſung, which ſervice ſundry are able to manage well.

THAT finiſhed, the preacher firſt prayeth, then preacheth, and then prayeth again. If it be the day for the Lord's ſupper to be celebrated, the church addreſs themſelves unto it, and the miniſter doth exactly perform it, according to the ſcriptures. When that ſervice is done, they ſing a pſalm, according to the pattern of Chriſt; then he bleſſeth the church, and ſo finiſheth the morning ſervice.

IN the afternoon they meet again, and perform all the parts of worſhip, as they did in the morning; which done, if there be any infant to be baptized, they perform that ſervice according to the ſcriptures; which done, the deacon calleth for contributions; which done, if there be any act of public diſcipline (as divers times there is, there being many failures among us) then the offender is called forth (being with care and diligence prepared) and is exhorted to give glory to God, and confeſs his ſin; which, being penitent, they gladly

accept him, forgive him, and receive him. If it be not a ſatisfactory confeſſion, they ſhew him his defect, they admoniſh and exhort him to a more full confeſſion; and ſo he is left to ſome other time. This finiſhed, he bleſſeth the church, and ſo diſmiſſeth the aſſembly.

MOREOVER, major *Gookins* hath dedicated his eldeſt ſon, Mr. *Daniel Gookins*, unto this ſervice of Chriſt; he is a pious and learned young man, about thirty three years old, hath been eight years a fellow of the college; he hath taught and trained up two claſſes of our young ſcholars, unto their commencement; he is a man, whoſe abilities are above exception, though not above envy. His father, with his inclination, adviſed him to *Sherborn*, a ſmall village near *Natik*, whoſe meeting-houſe is about three miles, more or leſs, from *Natik* meeting-houſe. Mr. *Gookins* holdeth a lecture in *Natik* meeting-houſe once a month; which lecture many Engliſh, eſpecially of *Sherborn*, do frequent. He firſt preacheth in Engliſh, to the Engliſh audience, and then the ſame matter is delivered to the Indians, by an interpreter, whom, with much pains, Mr. *Gookins* hath fore-prepared. We apprehend, that this will (by God's bleſſing) be a means to enable the Indians to underſtand religion preached in the Engliſh tongue, and will much further Mr. *Gookins* in learning the Indian tongue. Likewiſe major *Gookins* holdeth and manageth his courts in the Engliſh tongue; which doth greatly further the Indians in learning law and government in the Engliſh tongue; which is a point of wiſdom, in civilizing them, that your honours have manifeſtd your deſires, that it might be attended.

THE places, where the Indians meet to worſhip God, and ſanctify the ſabbath, are many; the moſt are ſtated places, others are occaſional. The ſtated places, in the *Maſſachuſets*, ſince the wars, are contracted into four, *Natik*, *Poukipoy*, *Wameſut*, and *Chachaubunkkakowok*. The occaſional meetings are at places of fiſhing, hunting, gathering cheſnuts in their ſeaſons. Alſo ſince the wars, the Mauquaoys, making incurſions upon the praying Indians, did cauſe them to make divers ſorts, to live ſafely in, and then they did there meet to worſhip God, and keep the ſabbath.

IN *Plymouth Pattent* there are about ten places, where they meet to worſhip God.

AN intelligent perſon, of *Martyn*'s vineyard, reckoned up unto me ten places, where God is worſhipped every Lord's day in that iſland.

AT *Nantukket* there be about five places, of prayer and keeping ſabbaths.

THE reaſon of this diſperſion of places of public meeting to worſhip God, is this; there is but here and there a ſpot of good land, fit for planting corn, with accommodation of fiſhing; theſe ſpots of good land lye at a great diſtance from each other; ſome four or five miles, ſome eight or nine miles, ſome ten or twelve miles: ſo that it is impoſſible for them, eſpecially with women and children, to meet at one place; therefore all, that live together at one place, meet to worſhip God on the ſabbath day.

THUS I have briefly repreſented before you, right honourable, at your command, the preſent eſtate of the praying Indians, in reſpect of their religion. And what I have here expreſſed, for the ſubſtance of the things, I know them to be true, and I have often ſo practiſed among them.

BY this it appeareth, that they are, in ſome good meaſure, able (by the light of the ſcriptures, and by the example of the churches of Chriſt, and by ſuch inſtruction as they have had) to practiſe and manage the whole inſtituted public worſhip of God among themſelves, without the preſence or inſpection of any Engliſh among them, which is no ſmall addition and advancement of the kingdom of Chriſt; and I doubt not but it ſhall add much comfort and joy to your ſouls here, and ſhall add much weight of glory to your ſouls hereafter, who have been ſo diligent, liberal and conſtant in your ſupplies for the encouragement of this work of Chriſt.

AND it is no ſmall comfort to me, whom divine providence and grace hath made one of the poor inſtruments, to inſtruct and manage them unto this eſtate in Chriſt Jeſus, whereunto they have attained.

As for the ſending any numbers of *Moſes*'s Pentateuch, I beſeech your honours to ſpare us in that; becauſe ſo many as we ſend, ſo many bibles are maimed, and made incomplete, becauſe they want the five books of *Moſes*. We preſent your honours with one book, ſo far as we have gone in the work, and humbly beſeech, that it may be acceptable, until the whole be finiſhed; and then the whole impreſſion (which is two thouſand) is at your honours command. Our ſlow progreſs needeth an apology. We have been much hindered by the ſickneſs this year. Our workmen have been all ſick, and we have but few hands, one Engliſhman, and a boy, and one Indian; and many interruptions and diverſions do befal us; and we could do but little this very hard winter. But I ſhall give your honours no further trouble at this time; only requeſting the continuance of your prayers and protection. So I remain,

Your honours

to ſerve you in our Lord Jeſus,

John Eliot.

POST-

POSTSCRIPT.

THE people of *Natik* have procured ſome friend of *Sherborn*, to draw up a letter to me, which I make bold to preſent to your honours view, being here incloſed. If I have been over bold herein, I beſeech your honours to pardon me.

IX.

Roxburg, Auguſt 29, 1686. in the third month of our overthrow.

Right honourable unwearіable nurſing father,

I HAVE nothing new to write but lamentations, and I am loth to grieve your loving and noble ſoul.

OUR Indian work yet liveth, praiſed be God; the bible is come forth, many hundreds bound up, and diſperſed to the Indians, whoſe thankfulneſs I intimate and teſtify to your honour. *The Practice of Piety* is alſo finiſhed, and beginneth to be bound up. And my humble requeſt to your honour is, that we may again reimpoſe the primer and catechiſm; for though the leſt impreſſion be not quite ſpent, yet quickly they will; and I am old, ready to be gone, and deſire to leave as many books as I can. I know not what to add in this diſtreſſing day of our overthrow; ſo I commit your honour to the Lord, and reſt,

Your honour's

to ſerve you in Jeſus Chriſt,

John Eliot.

X.

Roxburg, July 7, 1688.

Right honourable, deep learned, abundantly charitable, and conſtant nurſing father,

SIR,

I AM drawing home, and am glad of an opportunity to take my leave of your honour with all thankfulneſs. Sir, many years ſince you pleaſed to commit 30 *l.* into my hand, upon a deſign for the promoting Chriſt his kingdom among the Indians; which gift of yours I have religiouſly kept, waiting for an opportunity ſo to improve it; but God hath not pleaſed yet to open ſuch a door. I am old, and deſire to finiſh that matter, and take the boldneſs to requeſt your honour, that it may be thus diſpoſed of. It being in the hand of major *Gookins*'s relict widow, and he died poor, though full of good works, and greatly beneficent to the Indians, and bewailed by them to this day; therefore let his widow have 10 *l.* his eldeſt ſon, who holds up a lecture among the Indians and Engliſh 10 *l.* and the third 10 *l.* give it to Mr. *John Cotton*, who helped me much in the ſecond edition of the bible. And alſo I muſt commit to him the care and labour of the reviſal of two other ſmall treatiſes, *viz.* Mr. *Shegheard*'s *Sincere Convert* and *Sound Believer*, which I tranſlated into the Indian language many years ſince; and now I hope, that the honourable corporation will be at the charge to print them, by your honour's favour and countenance. But I cannot commit them to the preſs without a careful reviſal, which none but Mr. *Cotton* is able to help me to perform.

THE work in general ſeemeth to my ſoul to be in and well toward a reviving. Many churches of confeſſors of Chriſt are in motions to gather into church eſtate, who do carefully keep the ſabbath. And out of theſe profeſſors of religion, we do gather up and call in ſuch as are willing to confeſs Jeſus Chriſt, and ſeek ſalvation by him. Touching other matters, what our loſſes and changes be, and how trading, *&c.* are ſpoiled, I am ſilent; but my prayer to God is, *Iſaiah* i. 25, 26. *And I will turn my hand upon thee, and purely purge away thy droſs, and take away all thy tin, and I will reſtore thy judges as at the firſt, and thy counſellors as at the beginning*, &c. So do, O Lord.

SIR, the Lord prolong your days, and fill you with all grace, until you arrive at the fulneſs of glory, where I leave you, and reſt,

Your honour's

to ſerve you in Jeſus Chriſt,

John Eliot.

NUMBER VI.

Letters of thanks from the Governor, &c. of *New England*, to Mr. *Boyle*, for his ſervices to that Colony. *Life*, p. 87.

I.

Governor and General Court of New-England *to Mr.* Boyle.

Honourable Sir,

THE occaſion of our giving you this trouble is from the confidence we have of your favour and care of theſe his Majeſty's colonies in *New England*, manifeſted by your continued endeavours, as in promoting that good work of the natives converſion, ſo in taking opportunities for ingratiating us with his Majeſty and the right honourable the Lord Chancellor, as we underſtand by your letter to Mr. *Winthrop*, whereby you have given us that comfortable information of his Majeſty's grace towards us, in expreſſing himſelf in a very favourable manner, and that the Lord Chancellor did aſſure you, (with giving you commiſſion to aſſure our friends in the city) that the King intends not any injury to our charter, or the diſſolution of our civil government, or the infringement of our liberty of conſcience, and that the doing of thoſe things is not the buſineſs of the commiſſioners; the truth whereof we believe (as we ought) having the word of ſo gracious a King. But alas! Sir, the commiſſion impowering thoſe commiſſioners to hear and determine all cauſes, whether military, civil, or criminal, (what they have further by inſtruction at preſent we know not) ſhould this take place, what will become of our civil government, which hath been (under God) the hedge to that liberty for our conſciences, for which the firſt adventurers paſſed through, and bore up againſt all difficulties and diſcouragements, that encountered them, as in the way to, ſo in the continuance in this wilderneſs? Sir, we return unto you our true and hearty thanks for your former favours, and crave the continuance thereof as opportunity ſhall offer, and the great mover of hearts ſhall incline you in appearing our friend ſtill, that, if poſſible, the commiſſion may be recalled; for which end we have made our humble ſupplication to his Majeſty, in whoſe eyes if may we find favour, we and our poſterity ſhall have cauſe to bleſs the Lord. But if the decree be paſt, ſo that it may not be recalled, we ſhall wait the Lord's iſſue with us; and whatever may be the conjectures of any rendering alterations here adviſable, the iſſue will ſpeak them to be the ſubverſion of all that, which makes this place or our abode herein deſirable; or if any of thoſe, that deſire a dominion over us, (not to ſerve his Majeſty's intereſt in advancing plantation work, with the countenance of godlineſs, but to ſerve themſelves by his Majeſty's authority, and our ruin) ſhall prevail, it will to poſterity be rendered a diſſervice to his Majeſty's honour, and ſuch a damage, as the procurers will not be able to repair. We can ſooner leave our place, and all our preſent outward enjoyments, than leave that, which was the firſt ground of our wandring from our native country; nor are we thereby made ſuch ſtrangers thereunto, but we can rather chuſe to return, and take our lot with our brethren, than abide here under the deprivement of the ends of our travels. Our way is with the Lord. Craving your honour's pardon for this boldneſs, lifting up our beſt deſires to the Lord for you, we remain,

SIR,

Your humble ſervants,

in the name and by order of the General Court,
held at *Boſton* in *New-England*, Oct. 19, 1664.

Jo. Endecott, Governor.

II.

Mr. Boyle *to* Henry Aſhurſt, *Eſq;*

SIR,

I HAD ſooner ſent you an account of your letter, but that, although I delivered the petition to my Lord Chancellor, ſoon after I received it, and have waited on his Lordſhip ſeveral times ſince for an anſwer, yet I found him always engaged in buſineſs, either with the King, or Duke, or ſuch great perſons, as made me think it improper to deſire to be admitted. But being there this morning ſomewhat early, ſome of his relations, that ſaw me there, would needs bring me in, before I expected it, though a great perſon intervening obliged us to diſcourſe the moſt part aloud, till the Portugal reſident ſurprizing my Lord Chancellor with a requeſt to have audience, put an untimely end to our conference.

P. S. I FORGOT to tell you, that it is not all the New-Englanders, but only the Maſſachuſets, that have diſreſpectfully uſed the commiſſioners, to whom the reſt of the colonies have behaved themſelves otherwiſe. And when I ſpake civilly to my Lord Chancellor of your friend Mr. *Winthrop*, his Lordſhip aſſented to the character I had given him.

III.

Governor and Deputy Governor, &c. *of* New-England *to Mr.* Boyle.

Honourable Sir,

AS an addition to your former kindneſs, touching the preſent of maſts ſent from this colony to his Majeſty, we are lately informed, that you have been pleaſed to ſpeak on our behalf in the ears of his moſt excellent Majeſty, our gracious Sovereign, when our adverſaries, by their hard ſpeeches and falſe ſuggeſtions, have laboured to alienate his royal heart and affections from us; which favour of your's (to a people, that are ſo great ſtrangers to you, and ſo undeſerving your love) calls for gratitude. And therefore, ſhould we be ſilent in our moſt thankful acknowledgment thereof, firſt unto God, that hath ſo inclined your heart, and nextly, to your ſelf, as an inſtrument (and if we may preſume to ſay) an advocate for this part of God's poor church in the wilderneſs, it would render us moſt unworthy of our profeſſion.

SIR, we need not put you in mind, that the poor church of Chriſt, in all ages, even from righteous *Abel*'s time unto this day, hath not wanted adverſaries: the ancient enmity, which God hath put between the two ſeeds, will never reconcile; that example in *Ezra*'s and *Nehemiah*'s time do ſufficiently evince this; for although the people of God then had ample charters from thoſe great princes, *Cyrus* and *Artaxerxes*, yet God was pleaſed, for the trial of his church, and the illuſtration of his own glory (in their ſalvations) to permit a *Sanballat*, a *Tobiah*, and others, falſely to accuſe that people, to thoſe princes, of diſloyalty. Sir, we hear, that our adverſaries there are plotting and deſigning againſt our peace; ſo much the more cauſe have we to lye in the duſt before the Lord, imploring his aſſiſtance and ſalvation, as the matter ſhall require. And alſo it is our duty, not to neglect the uſe of that little means, that is left us, in order to the preſervation of our quietneſs and liberties; among which, this application to yourſelf, and by you to our moſt gracious King (whoſe royal heart the Lord hath graciouſly inclined hitherto to favour our righteous cauſe) is the principal.

SIR, we hear of ſeveral things againſt us, which we do not particularly underſtand; but ſo far as is intimated to us, we will make bold here briefly to mention them, with our anſwers to them.

I. OUR loyalty is queſtioned. To this we anſwer (in all humility, not boaſtingly) that the demonſtrations of our loyalty are known to thouſands; particularly, 1. We never proclaimed or acted in the name of the late power in *England* in his Majeſty's abſence, as all other remote colonies did. 2. It is known, that in our public prayers, as well as in private families, we pray for our King. 3. When a ſquadron of his ſhips, under Sir *John Harman*, commander, were in the *Weſt-Indies* ſtreightened for proviſions, we freely and ſeaſonably ſent a ſhip laden with proviſions for their ſupply. 4. In that preſent of a ſhip laden with maſts, ſent for the ſupply of his royal navy. Thoſe two laſt things coſt this poor colony ſome thouſands of pounds; and we have not heard, that any of his Majeſty's colonies (though far exceeding us in riches) have given higher demonſtrations of their loyalty.

II. WE are ſaid to be factious in the principles of religion. Anſwer. If Mr. *Perkins*, and thoſe good old Puritans, in King *Edward* the VIth and Queen *Elizabeth*'s time, did, in their principles or religion, teach evil doctrine (which we conceive no true Proteſtant will ſay) then may we be rendered ſuch; for our religion and principles are the ſame for ſubſtance with thoſe old Chriſtians and reformers called Puritans.

III. IT is ſaid, we are a divided people. We acknowledge, it is a matter to be greatly bewailed, that the church of God, all the world over (by reaſon of man's weakneſs and infirmity) doth labour under diverſity of perſuaſions and apprehenſions in matters of religion, and conſequently do not live in that bleſſed and ſweet unity, that God requires: but for our parts (ſome petty differences excepted) we bleſs God, we have much peace and tranquillity in church and ſtate.

IV. WE are charged with carrying it diſreſpectfully towards his Majeſty's commiſſioners. To this we ſay, that God and man can witneſs for us, that our treatment of them was with civility, according to our mean conditions. Indeed, as to yielding obedience unto their mandates, which were deſtructive to our royal charter; as that was contrary to his Majeſty's inſtructions and letter ſent to us by them, ſo we had no reaſon to ſubmit to them therein.

V. WE are blamed for a great omiſſion touching baptizing of infants. To this we anſwer, that our principles declared to the world in print, particularly that of the laſt ſynod held here, doth ſpeak our judgments to run parallel with other reformed churches, viz. That viſible confederate believers and their ſeed are ſubjects of baptiſm. Indeed in practice there hath been ſome omiſſions thereof, as to the largeſt extent, eſpecially in ſome places; but endeavours are daily uſed to reduce each one to the rule.

VI. WE

VI. We are accuſed of rigidneſs to ſuch as differ from us in matters of religion. To this we ſay, that from the firſt ſettling this plantation, theſe hetrodoxes of Familiſm, Anabaptiſm, and of late Quakeriſm, have been looked upon by the godly here, as great errors, and the promoters of them diſturbers of peace and order. Thoſe awful and tremendous motions of that ſort of people in *Germany*, and elſewhere, hath ſufficiently alarmed all pious and prudent men to provide a defenſative againſt them. Hence, from our firſt times, laws have been made to ſecure us from that danger; which have, at ſome times, upon juſt occaſions, been executed upon ſome of that ſort of people, who have exceeded the rules of moderation in matters of practice: but this we may ſay truly, that ſome peaceable Anabaptiſts, and ſome of other ſects, who have deported themſelves quietly, have and do live here, under the protection of this government, undiſturbedly.

Lastly, we are accuſed for graſping after dominions, more than belongs to us, and in particular, for taking in a place, called the Province of *Mayne*, belonging to Mr. *Gorge*. To this we anſwer, that our patent (which is of greater antiquity than his) doth take in that place; and this may be clearly demonſtrated. Again, Mr. *Gorge*'s predeceſſor, finding no profit, deſerted the government thereof, and left the people under ſuch confuſion and diſorder, that they were neceſſitated to petition earneſtly unto the Maſſachuſets, to take them under their government; which they did, at their earneſt deſire, to prevent their devouring one another. The truth is, there is no profit or benefit doth accrue to our government by their addition, but cumber and trouble. They are generally a very poor people, and contribute nothing to us, for the ſupport of government in this place. We may truly ſay, our main end in taking them under us hath been a deſire to do them good, outwardly and inwardly; eſpecially to encourage a pious and able miniſter to live among them, and to preach the Goſpel to them, which, through the favour of God, hath been in ſome meaſure attained. Before they came under us, we know not of one preaching and pious miniſter in five or ſix villages there, and ſince (through God's favour) they have been well provided therewith. Godly miniſters indeed were very ſhy to go among them to live, before they were ſettled under this government; and at ſuch time, when the commiſſioners took them off from us, and ſettled ſome juſtices among themſelves, it was but a little while after the commiſſioners were gone, but that people fell into ſuch diviſions and confuſions, that many of their miniſters left them; and the people again earneſtly ſued to us for protection and government, finding no benefit (as they alledged) by ſuch, as the commiſſioners had appointed to rule them. Peradventure Mr. *Gorge* and ſome others may apprehend, they are deprived of honour and profit by us in this matter; but, we believe, as it hath, ſo it will be found, that neither the one nor the other would accrue to them, if they had it under their power, according to their deſire.

Thus, noble Sir, we have made bold to give you an account (as briefly as we could) of what we hear is objected againſt us, and our anſwer; committing all to your goodneſs and wiſdom, to make uſe of as you ſhall ſee occaſion.

So deſiring, in all humility, your pardon for our preſumption, in giving you this trouble, with our cordial prayers unto the God of all mercy and grace, to pour upon your head and heart his richeſt bleſſings; with our moſt humble ſervice and love to you preſented, we take leave, deſiring always to remain,

Your honour's

moſt affectionate friends and ſervants,

John Leverett, Governor.
Samuel Symonds, Deputy Governor.
Daniel Gookins, Aſſiſtant.
Richard Ruſſell.
Thomas Dauforth.
John Pynchon.
William Stoughton.
Edward Tyng.

This is a duplicate of a letter ſent in December laſt. Dated in *Boſton* in *New-England*, May 10, 1673.

PREFACES

PREFACES

OF

Mr. *BOYLE*

TO

BOOKS wrote by other perſons, ADVERTISEMENTS, &c.

Mr. *Boyle*'s Preface to *A Tract touching the Skill of a better Way of Anatomy of Man's Body*, by *Yonker Louis de Bills*, Lord of *Koppenſdam*, &c. tranſlated from the *Low-Dutch*, by Mr. *Pell*, and printed at *London*, 1659, in 12mo.

To my much eſteemed friend Samuel Hartlib *the elder, Eſq;*

SIR, Octob. 13, 1659.

YOUR deſires were wont to tend ſo much to the public good, that your virtuoſi would think I wanted philanthropy, as well as civility, if I ſhould refuſe to comply with ſuch as your letter brings me. I ſend you therefore the propoſitions of monſieur *de Bills*, Engliſhed out of Low-Dutch, at my requeſt, by ſuch a perſon, as you will readily think can tranſlate very well, though he can better write things worthy to be tranſlated, when I ſhould have told you, that his name is Mr. *Pell*. The deſign avowed to be aimed at in the propoſitions, and much more the matter of fact, without which they might appear extravagant, made the print, I confeſs, very welcome to me. For though in ſome papers I formerly told you of, I had mentioned divers things I had intended to try, and ſome, that I had already obſerved, in order to the preſervation of animal ſubſtances, and the making ſome of them more durable ſubjects for the anatomiſt to deal with; yet beſides that moſt of the ways I propoſed to myſelf were as yet little more than bare deſigns, I never aimed at, (and ſcarce ſo much as hoped for) ſuch ſtrange things, as in this paper the ingenuous publiſher of it tells us he hath already actually performed. And therefore I I ſuppoſe, that it will not be unwelcome to you, if, not having had the opportunity to ſee the effect of this gentleman's ſkill myſelf, and being ſufficiently indiſpoſed to believe or affirm any ſtrange thing, that I have not ſeen, I annex the other paper you lately deſired of me; I mean that, wherein the propoſer's Dutch print came incloſed to me from the *Hague*. For beſides that it contains ſomething of particular, it comes from a French gentleman, whoſe teſtimony may well be conſiderable in matters of this nature; for he is one of that ſelect ſociety of Pariſian philoſophers, of which you and I have ſometimes diſcourſed; and you will find a celebrating mention made of him in the life of *Gaſſendus*, whoſe friend and diſciple he was. And his curioſity leading him to imitate divers of the old Greek philoſophers, who travelled through many countries, only to enrich themſelves with what knowledge they could meet with in them, he went purpoſely to viſit monſieur *de Bills*, ſoon after he had left *England*, which he lately traverſed; and in his paſſage honoured me with ſeveral of his viſits. I am ſo willing

 that

that you ſhould be as wary as I in admitting unlikely things into your belief, that, in putting the French I received into Engliſh, I have been (purpoſely to avoid ſtraining his expreſſions) more careful to do right to his words, than to his ſtile. And as for thoſe things, that appear to have been left out by me, they are ſome of them ſuch matters as concern not our propoſer, and others but ſuch compliments, as require rather my bluſhes, than my tranſlating. The conſent you deſire of me to publiſh the propoſals in our language I muſt not refuſe you. For it is the leaſt we owe to a perſon, that hath endeavoured to oblige mankind, and to thoſe, that are willing to encourage ſuch endeavours, by acquainting the ingenious here with his propoſitions, to ſtrive to procure him ſubſcribers, and to afford them the opportunity of encouraging and aſſiſting ſo uſeful a work, as this (ſuppoſing the truth of the hiſtorical part of the paper) is like to prove. It may alſo be hoped, that the noiſe of ſuch diſcoveries abroad will rouſe up our ingenious men at home, and excite them to endeavour to emulate, if not ſurpaſs them; and to keep up that reputation for anatomical diſcoveries and ſkill, that this nation hath of late deſervedly enjoyed. Nor will it be amiſs, by the ſame means, to give as many of thoſe in authority, as may happen to read what the ſtates of *Holland* have done, in favour of a ſtranger, occaſion to take notice, what countenance neighbouring magiſtrates, that are not thought unpolitic neither, are forward to give to thoſe deſigns, that aim at the advancement of real learning. Which may perhaps invite thoſe, that can do it, to give encouragement to the Engliſh wits; which I am groundedly confident want nothing but encouragement, to perform things in this kind, that would really advantage the public, as well as highly gratify ſuch perſons as Mr. *Hartlib*, and his

affectionate humble ſervant,

Robert Boyle.

A

LETTER

Prefixed to a Tract tranſlated from French into Engliſh,

BY

Dr. *PETER DU MOULIN,*

ENTITLED,

The DEVIL of *MASCON:*

The fourth edition of which was printed at *Oxford*, 1669, in 12mo.

To my reverend and learned friend, Dr. Peter du Moulin.

SIR,

THOUGH I ſuppoſe you will look upon my ſending you Monſieur *Perreaud*'s French book, as a minding you of the promiſe you were the other day pleaſed to make me of putting it into an Engliſh dreſs; yet I hope you will do me the right to believe, that if the ſubject were not extraordinary, and if my own pen were not (as you know it is) pre-engaged to a theme of a very diſtant nature, I ſhould think it injurious to the public, and to you, to be acceſſary to his turning tranſlator of another's books, that hath already manifeſted in ſeveral languages, how able he is to write excellent ones of his own.

I MUST freely confeſs to you, that the powerful inclinations, which my courſe of life and ſtudies hath given me to diffidence and backwardneſs of aſſent, and the many fictions and ſuperſtitions, which (as far as I have hitherto obſerved) are wont to blemiſh the relation, where ſpirits and witches are concerned, would make me very backward to contribute any thing to your publiſhing, or any man's believing, a ſtory leſs ſtrange than this of Monſieur *Perreaud.*

BUT the converſation I had with that pious author during my ſtay at *Geneva*, and the preſent he was pleaſed to make me of this treatiſe before it was printed, in a place where I had opportunities to enquire both after the writer, and ſome paſſages of the book, did at length overcome in me (as to this narrative) all my ſettled indiſpoſedneſs to believe ſtrange things. And ſince I find, that you have received an account both of Monſieur *Perreaud* himſelf, and ſeveral things relating to his book, from that great ſcholar and excellent perſon your father, I have no reaſon to doubt, but that as your ſkill in the tongues, out of which and into which this treatiſe is to be tranſlated, will bring it the greateſt advantages, that it can receive from a tranſlator's pen; ſo the reputation, which your and your learned father's names will give it, will prove as effectual as any thing of that nature can be, to make wary readers as much believe even the amazing paſſages of it, as I hope you do that great truth of my being in a high degree,

SIR,

your affectionate friend and humble ſervant,

Robert Boyle.

An Advertiſement of Mr. *BOYLE's*,

About the loſs of many of his writings, addreſſed to *J. W.* to be communicated to thoſe of his friends, that are virtuoſi; which may ſerve as a kind of preface to moſt of his mutilated and unfiniſhed writings. *London*, printed in May 1688, two pages, folio.

AS for the report, that doubtleſs has reached your ears, of the loſs of ſeveral of my manuſcripts, and the defacing of divers others, it is but too true; and I am very ſenſible of it. But yet it is not barely upon my own account, that I am ſo, but very much upon that of my inquiſitive friends, and Mr. *J. W.* in particular. For I cannot be but troubled, that I find myſelf diſabled to anſwer the expectation they had, that I ſhould gratify their curioſity, by entertaining them with ſeveral tracts upon philoſophical ſubjects; and that ſome unwelcome accidents, that have of late befallen me, oblige me to diſſuade them from expecting hence-forward, that I ſhould preſent them with almoſt any treatiſe, finiſhed and entire. For having been for many years afflicted with a weakneſs of ſight, that neceſſitated me, inſtead of writing myſelf, to dictate to others; and having been neceſſitated to make ſeveral removes, ſome of them with too much haſte to permit me to take an exact care of my papers, or keep all of them together, and take them along with myſelf, from place to place: when, not long ſince, I had occaſion to review and range them, I found, to my ſurprize, as well as trouble, that I wanted four or five centuries of experiments of my own, and other matters of fact, which from time to time I had committed to paper, as they were made and obſerved, and had been, by way partly of diary, and partly of adverſaria, regiſtered and ſet down, one century after another, that I might have them in readineſs to be made uſe of in my deſigned treatiſes. And together with theſe matters of fact, I found miſſing ſeven or eight centuries of notions, remarks, explications and illuſtrations of divers things in philoſophy, which I had committed to writing, as they chanced to occur to my thoughts, and which might have place among the ſame papers with the abovementioned experiments. How all theſe ſhould come to be loſt, whilſt ſome other centuries of notes and ſhort memoirs, ſome of them ſpeculative, and others experimental, eſcaped, I can as little declare, as recover them. But, to add to the misfortune (for ſuch it is to me, though perhaps not to the world) one, whom I had ordered to do ſomething with a bottle of oil of vitriol, unluckily broke the glaſs juſt over a flat cheſt of drawers, which I had purpoſely cauſed to be made for no other uſe, than to keep in it my own manuſcript papers, whereof it had then good ſtore. And though I happened to be at that time in the room, and made haſte to unlock the diſtinct drawers, and take them out; yet the highly corroſive liquor had made ſuch haſte and ſuch havock, that ſeveral manuſcripts, and among them ſome that I moſt valued, were quite ſpoiled; inſomuch, that there remained not words enough undefaced to declare what ſubject they concerned; and that the other manuſcripts, that miſchievous liquor had reached to, had ſome of them their leaves half conſumed, and others a greater or leſſer part of them; and all that the menſtruum touched, it made ſo rotten, that, notwithſtanding all our diligence, what was once wetted, could never be retrieved.

IT was natural enough, that this concourſe of miſchances ſhould ſuggeſt to me, that I was to take new meaſures in reference to my deſigned but yet unpubliſhed writings. For firſt it ſeemed reaſonable, that either I ſhould wholly ſuppreſs ſome diſcourſes, wherein I had made a conſiderable progreſs, but had not finiſhed them, or elſe ſhould at leaſt acknowledge and give notice they are incomplete, and blemiſhed with divers chaſms, ſince a great many particulars are loſt, that ſhould have done more than fill up thoſe vacancies: which defects I cannot now ſupply, many of the experiments having been made, when I had by me ſome ſuch drugs and other materials, and ſuch exact inſtruments and ſkilful workmen, as I am not now furniſhed with, nor am able to retrieve. Beſides that, I was then alſo ſometimes befriended by opportunities and favourable circumſtances, that I cannot hope for again.

To this firſt reflection it was natural to add another; which was, that ſince I could neither diſcover nor imagine, how moſt of the writings lately mentioned (with ſome others about differing ſubjects) came to be loſt; the ſureſt courſe, (if not the only ſure one) that I could take to prevent the like accidents for the future, would be to publiſh from time to time, as faſt as conveniently I could, thoſe remains and fragments, as well as leſs mutilated papers, that yet continued in my hands, premiſing to each diſtinct bundle of them an admonition to thoſe readers, that care for no books, that are not methodical and complete, that they were not only free, but deſired to paſs theſe by, as pieces both confuſed and unfiniſhed.

I MIGHT add, that perhaps it may be more prejudicial to the author than to the reader, that theſe papers come forth with ſuch diſadvantageous circumſtances; ſince, for the moſt part, the method of writings, that treat about experimental philoſophy, is not much minded and remembered by the reader, at leaſt after the firſt peruſal; the notions and experiments themſelves abſtracting from the order they were delivered in, being the things, that philoſophers uſe to take notice of, and permanently retain in their memories. The introductory diſcourſes and prefaces to be met with among ſome of the very incomplete papers, that accompany this letter, may perhaps not be unwelcome nor altogether uſeleſs to ſome ingenious men, who will not be diſpleaſed to find themſelves excited, and perchance ſomewhat aſſiſted, to take particular notice of ſome ſubjects, that ſeem worthy of being more thoroughly conſidered and cultivated than yet they have been; and ſome perchance may think the deſigns I had upon ſome ſubjects, not unfit to be purſued by them in their own way and ſtile. And as for theſe heaps of fragments, that ſeem to be more of a chaotic nature (if I may ſo ſpeak) ſince the particulars they mainly conſiſt of, are matters of fact, their being huddled together, without method (though not always without order) may not hinder them from being fit, if well diſpoſed of, to have places ſomewhere or other in the hiſtory of nature; and to become not unſerviceable materials in the ſtructure, that is aimed at in this age, of an uſeful and well grounded philoſophy.

A TABLE

A TABLE of CONTENTS of the FIVE VOLUMES.

The CONTENTS of the FIRST VOLUME.

I. NEW Experiments *Phyſico-mechanical*, touching the *Spring* of the *Air*, and its Effects; made, for the moſt part, in a new Pneumatical Engine; written by way of Letter to the Right Honourable *Charles* Lord Viſcount of *Dungarvan*, eldeſt Son to the Earl of *Cork*. Page 1

II. A Defence of the Doctrine touching the *Spring* and *Weight* of the *Air*, propoſed by Mr. *Robert Boyle* in his new *Phyſico-mechanical* Experiments, againſt the Objections of *Franciſcus Linus*, wherewith the Objector's *Funicular* Hypotheſis is alſo examined. 76

1. A Defence of Mr. *Robert Boyle*'s Explications of his *Phyſico-mechanical* Experiments, againſt *Franciſcus Linus*, Part 1. wherein the Adverſary's Objections againſt the Elateriſts are examined. 79
2. Part the Second, wherein the Adverſary's Funicular Hypotheſis is examined. 86
3. An Explication of Rarefaction. 113
4. An Explication of the *Rota Ariſtotelica*. 117

III. An Examen of Mr. *T. Hobbes*'s *Dialogus Phyſicus de Naturâ Aëris*, as far as it concerns Mr. *Boyle*'s Book of New Experiments touching the *Spring* of the *Air*, *&c.* With an Appendix touching Mr. *Hobbes*'s Doctrine of *Fluidity* and *Firmneſs*. 118

1. An Examen of the greateſt Part of Mr. *Hobbes*'s *Dialogus Phyſicus de Naturâ Aëris*. 120

IV. Some Motives to the LOVE OF GOD, pathetically diſcourſed of in a Letter to a Friend. 155

V. An occaſional Reflection upon a Letter received in *April* 1662, concerning an Account of what paſſed on the King's *Coronation-day*, in a little Country Town. 188

VI. Certain PHYSIOLOGICAL ESSAYS, and other Tracts written at diſtant Times, and on ſeveral Occaſions. 191

1. A *Proœmial Eſſay*, wherein, with ſome Conſiderations touching Experimental Eſſays in general, is interwoven ſuch an Introduction to all thoſe written by the Author, as is neceſſary to be uſed for the better underſtanding of them. 192
2. Two *Eſſays* concerning the Unſucceſſfulneſs of Experiments, containing divers Admonitions and Obſervations (chiefly Chymical) touching that Subject. The firſt Eſſay, of the Unſucceſsfulneſs of Experiments. 204
3. The ſecond Eſſay, on unſucceeding Experiments. 214
4. Some Specimens of an Attempt to make *Chymical* Experiments uſeful to illuſtrate the Notions of the *Corpuſcular* Philoſophy. 227
5. A *Phyſico-chymical* Eſſay, containing an Experiment, with ſome Conſiderations touching the differing Parts and *Redintegration* of *Salt-Petre*. 230
6. The Hiſtory of *Fluidity* and *Firmneſs*. The firſt Part, of *Fluidity*. 240
7. The Hiſtory of *Fluidity* and *Firmneſs*. The ſecond Part, of *Firmneſs*. 254
8. Of abſolute *Reſt* in Bodies. An Eſſay of the inteſtine Motions of the Particles of *quieſcent* Solids, where the abſolute Reſt of Bodies is called in queſtion. 281

VII. The SCEPTICAL CHYMIST; or Chymico-Phyſical Doubts and Paradoxes touching the Experiments, whereby Vulgar *Spagyriſts* are wont to endeavour to evince their *Salt*, *Sulphur* and *Mercury* to be the true Principles of Things; to which, in this Edition, are ſubjoined divers Experiments and Notes about the Producibleneſs of *Chymical* Principles. 290

VIII. Phyſiological Conſiderations touching the Experiments wont to be employed to evince either the four *Peripatetic Elements*, or the three *Chymical Principles* of mixed Bodies. Part of the firſt Dialogue. 294

1. The Sceptical Chymiſt. Part I. 300
2. Part II. 312
3. Part III. 323
4. Part IV. 329
5. Part V. 344
6. Part VI. 356

IX. Experiments and Notes about the Producibleneſs of *Chymical Principles*, being Parts of an Appendix deſigned to be added to the *Sceptical Chymiſt*. 372

1. Of the Producibleneſs of *Chymical Principles*. Part I. Of Salt. 376
2. Of the Producibleneſs of *Spirits*. Part II. 386
3. Of the Producibleneſs of *Sulphurs*. Part III. 393
4. Of the Production of *Mercury*. Part IV. 398
5. Of the Producibleneſs of *Phlegm* or *Water*. Part V. 412
6. Of the Producibleneſs of *Earth*. Part VI. 415

X. Some Conſiderations touching the Uſefulneſs of *Experimental Natural Philoſophy*, propoſed in a familiar Diſcourſe to a Friend, by way of Invitation to the Study of it. 420

1. Eſſay I. The Uſefulneſs of *Experimental Philoſophy*, principally as it relates to the Mind of *Man*. 423
2. Eſſay II. Of the ſame. 429
3. Eſſay III. Containing a Continuation of the former. 440
4. Eſſay IV. Containing a requiſite Digreſſion concerning thoſe that would exclude the *Deity* from intermeddling with *Matter*. 444
5. Eſſay V. Wherein the Diſcourſe interrupted by the late Digreſſion is reſumed and concluded. 453

XI. Of the Uſefulneſs of *Natural Philoſophy*. Part II. Sect. I. Of its Uſefulneſs to *Phyſick*. 463
1. Eſſay II. Offering ſome Particulars relating to the *Pathological* Part of *Phyſick*. 471
2. Eſſay III. Containing ſome Particulars relating to the *Semeiotical* Part of *Phyſick*. 480
3. Eſſay IV. Preſenting ſome Things relating to the *Hygieinal* Part of *Phyſick*. 489
4. Eſſay V. Preſenting ſome Particulars, wherein Natural Philoſophy may be uſeful to the *Therapeutical* Part of *Phyſick*. 496
5. An Appendix to the firſt Section of the ſecond Part. 554

The CONTENTS of the SECOND VOLUME.

I. EXperiments and Conſiderations touching *Colours*, firſt occaſionally written among ſome other Eſſays to a Friend, and now ſuffer'd to come abroad as the Beginning of an Experimental Hiſtory of *Colours*. 1
1. The Experimental Hiſtory of *Colours*. The firſt Part. 5
2. The Experimental Hiſtory of *Colours*. Part II. Of the Nature of *Whiteneſs* and *Blackneſs*. 23
3. Experiment in Conſort touching *Whiteneſs* and *Blackneſs*. 31
4. The Experimental Hiſtory of *Colours* begun. Part II. Containing promiſcuous Experiments about *Colours*. 41

II. A ſhort Account of ſome Obſervations made by Mr. *Boyle* about a *Diamond* that ſhines in the *dark*. 81

III. Some Conſiderations touching the Style of the Holy Scriptures, extracted from ſeveral Parts of a Diſcourſe concerning divers Particulars belonging to the Bible, written divers Years ſince to a Friend. 88

IV. Occaſional Reflections upon ſeveral Subjects, whereto is premiſed a Diſcourſe about ſuch kind of Thoughts. 138
1. A Diſcourſe touching Occaſional *Meditations*. 146
2. Occaſional Reflections. 162

V. New Experiments and Obſervations touching *Cold*, or an Experimental Hiſtory of *Cold* begun; to which are added, An Examen of *Antiperiſtaſis*, and an Examen of Mr. *Hobbes*'s Doctrine about *Cold*; whereunto is annexed an Account of *Freezing*, brought into the Royal Society by the learned *C. Merret*, a Fellow of it. Together with an Appendix containing ſome promiſcuous Experiments and Obſervations relating to the precedent Hiſtory of *Cold*. 228
1. New Thermometrical Experiments and Thoughts. Diſcourſe I. Propoſing the firſt *Paradox*, *viz.* that not only our Senſes, but common Weather-glaſſes may miſinform us about Cold. 240
2. Diſcourſe II. Containing ſome new Obſervations touching the New or *Hermetical Thermometer*. 246
3. Diſcourſe III. Containing the ſecond Paradox, *viz.* touching the Cauſe of the *Condenſation of Air*, and Aſcent of Water by *Cold* in common *Weather-glaſſes*. 252
4. The Paper prefixed, as a ſhort prefatory Addreſs to the Hiſtory of *Cold*. 257
5. The Experimental Hiſtory of *Cold* begun. 258
6. The Examen of *Antiperiſtaſis*, as it is wont to be taught and proved. 355
7. A Sceptical Conſideration of the *Heat* of *Cellars* in Winter, and their *Coldneſs* in Summer. 370
8. An Examen of Mr. *Hobbes*'s Doctrine touching *Cold*. 373
9. An Account of *Freezing* made in *December* and *January* 1662. 381
10. An Appendix, containing ſome promiſcuous Experiments and Obſervations relating to the preceding Hiſtory of *Cold*. 391
11. The Phænomena of an Experiment about *Freezing*, made by Mr. *Boyle*. 393

VI. Obſervables upon a *monſtrous Head*; ſome *anatomical* Obſervations of *Milk* found in Veins inſtead of *Blood*, and of *Graſs* found in the *Wind-pipes* of ſome Animals. 403

VII. Of a Place in *England* where, without *petrifying* Water, *Wood* is turned into *Stone*. A further Account of an Obſervation about *white Blood*. 408

VIII. Hydroſtatical *Paradoxes* made out by new Experiments, for the moſt part *Phyſical* and eaſy. 409

IX. A Confirmation of an Account touching the late *Earthquake* near *Oxford*, and the Concomitants thereof. 448

X. Some Obſervations and Directions about the *Barometer*. 449

XI. Origin of *Forms* and *Qualities* according to the *Corpuſcular* Philoſophy, illuſtrated by Conſiderations and Experiments, written formerly by way of Notes upon an Eſſay upon *Nitre*. 451
1. Conſiderations and Experiments touching the *Origin* of *Forms* and *Qualities*, the *Theorical* Part. 460

2. An Excurſion about the relative Nature of *Phyſical Qualities.* Page 462
3. An Examen of the *Origin* and Doctrine of *ſubſtantial Forms*, as it is wont to be taught by the *Peripateticks.* 476
4. Experiments and Thoughts about the Production and Reproduction of *Forms.* 484
5. Doubts and Experiments touching the curious Figures of *Salts.* 488
6. Experimental Attempts about the *Redintegration* of Bodies. 492
7. Conſiderations and Experiments touching the *Origin* of *Qualities* and *Forms*, the Hiſtorical Part. 496
8. Three Conſiderations about *Subordinate Forms*, as they are wont to be maintained by divers learned Moderns. 526

XII. A Way of preſerving *Birds* taken out of the *Egg*, and other ſmall *Fœtus's.* 543

XIII. An Account of a new kind of *Baroſcope*, which may be called *Statical*, and of ſome Advantages and Conveniencies it hath above the *Mercurial.* 543

XIV. The Method obſerved of *transfuſing* the *Blood* of one Animal into another. 550

XV. Trials propoſed to Dr. *Lower* to be made by him for the Improvement of *transfuſing Blood* out of one live Animal into another. 552

XVI. Propoſals to try the Effects of the *Pneumatick Engine* exhauſted in Plants, Seeds, Eggs of Silkworms. 553

XVII. A Confirmation of the Experiments made by Signor *Fracaſſati* in *Italy* by injecting acid *Liquors* into *Blood.* 554

XVIII. New Experiments concerning the Relation between *Light* and *Air* in *ſhining Wood* and *Fiſh*, made by the Author, and by him addreſſed from *Oxford* to the Publiſher, and ſo communicated to the *Royal Society.* 555

The CONTENTS of the THIRD VOLUME.

I. A Continuation of new Experiments *Phyſico-mechanical*, touching the *Spring* and *Weight* of the Air, and their Effects. The Firſt Part; written by way of Letter to the Right Honourable the Lord *Clifford* and *Dungarvan.* Whereto is annexed a ſhort Diſcourſe of the *Atmoſpheres* of *conſiſtent* Bodies. 1
1. Notes, *&c.* about the *Atmoſpheres* of *conſiſtent* Bodies here below, ſhewing that even hard and *ſolid* Bodies (and ſome ſuch as one would ſcarce ſuſpect) are capable of emitting *Effluvia*, and ſo of having *Atmoſpheres.* 64

II. Tracts about the *Coſmical* Qualities of Things. *Coſmical Suſpicions.* The Temperature of the *Subterraneal Regions.* The *Bottom* of the *Sea.* 72
1. The Hiſtory of particular *Qualities.* 73
2. Of the *Syſtematical* or *Coſmical* Qualities of Things. 82
3. *Coſmical Suſpicions* ſubjoined as an Appendix to the Diſcourſe of the *Coſmical Qualities* of Things. 88
4. Of the Temperature of the *Subterraneal* Regions as to *Heat* and *Cold.* 95
5. Of the Temperature of the *Submarine* Regions as to *Heat* and *Cold.* 105
6. Relations about the *Bottom of the Sea.* 110

III. New *Pneumatical* Experiments about *Reſpiration.* 114
1. The Continuation of the Experiments concerning *Reſpiration.* 123

IV. Some Conſiderations touching the Uſefulneſs of *Experimental Natural Philoſophy*, propoſed in a familiar Diſcourſe to a Friend, by way of Invitation to the Study of it. The ſecond Tome, containing the latter Section of the Second Part. 135
1. Of the Uſefulneſs of *Experimental* Philoſophy. The Second Part, the Second Section.
2. Of its Uſefulneſs to the *Empire* of *Man* over inferior Creatures. 141
3. Of the Uſefulneſs of *Mathematicks* to *Natural Philoſophy*, or that the Empire of *Man* may be promoted by the Naturaliſt's Skill in *Mathematicks*, (as well pure as mixed.) 156
4. Of the Uſefulneſs of *Mechanical* Diſciplines to *Natural* Philoſophy, ſhewing that the Power of *Man* may be much promoted by the Naturaliſt's Skill in *Mechanicks.* 162
5. That the Goods of Mankind may be much increaſed by the *Naturaliſt's* Inſight into *Trades.* 167

V. Of doing by *Phyſical* Knowledge what is wont to require *Manual* Skill, or that the Knowledge of peculiar *Qualities* or Uſes of *Phyſical* Things may enable a Man to perform thoſe Things *Phyſically*, that ſeem to require *Tools* and *Dexterity* of Hand proper to *Artificers.* 177

VI. Eſſay X. Of Men's great *Ignorance* of the Uſes of *Natural* Things, or that there is ſcarce any one Thing in Nature, whereof the Uſes to human Life are yet thoroughly underſtood. 185

VII. Tracts of a Diſcovery of the admirable *Rarefaction* of the *Air.* New Obſervations about the Duration of the *Spring* of the *Air.* New Experiments touching the *Condenſation* of the *Air* by mere *Cold*, and its *Compreſſion* without Mechanical Engines. The admirably differing *Extenſion* of the ſame Quantity of *Air* rarefied and compreſſed. 202
1. A Diſcovery of the admirable *Rarefaction* of *Air* (even without *Heat*) imparted in a Letter to a Friend. 203
2. New Obſervations about the *Duration* of the *Spring* of *expanded Air*, ſubjoined by way of Appendix to the foregoing Epiſtle. 206
3. New Experiments touching the *Condenſation* of the *Air* by mere *Cold*, and its *Compreſſion* without Mechanical Engines. 209

4. Of the admirably differing *Extenſion* of the ſame Quantity of *Air* rarefied and compreſſed. Page 211
VIII. An Obſervation of a *Spot* in the *Sun*. 213
IX. An Eſſay about the *Origin* and *Virtues* of *Gems*, wherein are propoſed, and hiſtorically illuſtrated, ſome Conjectures about the Conſiſtence of the Matter of *Precious Stones*, and the Subjects wherein their chiefeſt Virtues reſide. 214
1. An Eſſay about the Origin and Virtues of Gems. 216
X. Tracts, containing new Experiments touching the Relation betwixt *Flame* and *Air*, and about *Exploſions*. An Hydroſtatical Diſcourſe occaſioned by ſome Objections of Dr. *Henry More* againſt ſome Explications of new Experiments made by the Author of theſe Tracts; to which is annexed, An *Hydroſtatical* Letter, dilucidating an Experiment about a Way of *weighing Water in Water*. New Experiments of the *Poſitive* or *Relative Levity* of Bodies under *Water*; of the *Air's* Spring on Bodies under *Water*. About the differing Preſſure of heavy *Solids* and *Fluids*. 247
1. New Experiments touching the Relation between *Flame* and *Air*, ſent in a Letter to the learned Publiſher of the Philoſophical Tranſactions. 248
2. Of the Difficulty of producing *Flame* without *Air*. 250
3. Of the Difficulty of preſerving *Flame* without *Air*. 254
4. Of the ſtrangely difficult Propagation of actual *Flame* in *Vacuo Boyliano*. 258
XI. New Experiments about the Relation between *Air* and the *Flamma Vitalis* of Animals. 261
XII. An Attempt to produce *Living Creatures in Vacuo Boyliano*. 264
XIII. An Attempt made upon *Gnats* in our *Vacuum*. 265
XIV. New Experiments about *Exploſion*, annexed by way of Appendix to the former Papers. 266
XV. An *Hydroſtatical* Diſcourſe occaſioned by the Objections of the learned Dr. *Henry More* againſt ſome Explications of new Experiments made by Mr. *Boyle*. 268
XVI. An *Hydroſtatical* Letter written *February* 13, 167$\frac{2}{3}$. containing a Dilucidation of an Experiment of the Honourable Author of theſe Tracts, about a Way of *weighing Water* in *Water*, upon the Occaſion of ſome Exceptions made to it by Mr. *George Sinclair*. 289
XVII. New Experiments of the *Poſitive*, or *Relative Levity* of Bodies under *Water*. 293
XVIII. New Experiments about the *Preſſure* of the *Air's* Spring on Bodies under *Water*. 296
XIX. New Experiments about the differing Preſſure of heavy *Solids* and *Fluids*. 298
XX. Some Obſervations about *ſhining Fleſh*, both of *Veal* and *Pullet*, and that without any ſenſible *Putrefaction* in thoſe Bodies. 304
XXI. A New Experiment concerning an Effect of the varying *Weight* of the *Atmoſphere* upon ſome Bodies in the *Water*; ſuggeſting a Conjecture, that the very Alterations of the *Air*, in point of *Weight*, may have conſiderable Operations, even upon *Men's Sickneſs or Health*. 307
XXII. Eſſays of the ſtrange Subtilty, great Efficacy, determinate Nature of *Effluviums*; to which are annexed new Experiments to make *Fire* and *Flame* ponderable, together with a Diſcovery of the *Perviouſneſs* of *Glaſs*. 309
1. Of the ſtrange Subtilty of *Effluviums*. 310
2. Of the great Efficacy of *Effluviums*. 322
3. Of the determinate Nature of *Effluviums*. 328
4. New Experiments to make *Fire* and *Flame* ſtable and *ponderable*. 340
5. Additional Experiments about arreſting and *weighing* of *igneous* Corpuſcles. 347
6. A Diſcovery of the *Perviouſneſs* of *Glaſs* to ponderable Parts of *Flame*, with ſome Reflections on it by way of Corollary. 350
XXIII. Tracts conſiſting of Obſervations about the *Saltneſs* of the *Sea*. An Account of a *Statical Hygroſcope*, and its Uſes. Together with an Appendix about the Force of the *Air's* Moiſture. A Fragment about the *natural* and *preternatural* State of Bodies; to all which is premiſed, a *Sceptical* Dialogue about the *poſitive* or *privative* Nature of *Cold*. With ſome Experiments of Mr. *Boyle's* referred to in that Diſcourſe. 357
1. Two Problems about *Cold*, grounded on new Experiments, and propoſed in a Letter to a Friend. 371
2. An Attempt to manifeſt and meaſure the great expanſive Force of *freezing Water*. 373
3. A new Experiment about the Production of *Cold* by the Conflict of Bodies appearing to make an *Ebullition*. 374
4. Obſervations and Experiments about the *Saltneſs of the Sea*. 378
5. A Paradox of the *natural* and *preternatural* State of Bodies, eſpecially of the *Air*. 390
6. A *Statical Hygroſcope*, propoſed to be further tried. Together with a brief Account of the Utilities of *Hygroſcopes*. 393
7. A new Experiment, and other Inſtances of the Efficacy of the *Air's* Moiſture, ſubjoined by way of Appendix to his *Statical Hygroſcope*. 400
XXIV. The Excellency of *Theology* compared with *natural* Philoſophy, (as both are Objects of Men's Study) diſcourſed of in a Letter to a Friend; to which are annexed ſome occaſional Thoughts about the Excellency and Grounds of the *mechanical Hypotheſis*. 404
1. The Excellency of *Theology*, or the Pre-eminence of the Study of *Divinity* above that of *Natural* Philoſophy. 408

2. About the Excellency and Grounds of the *mechanical Hypotheſis*; ſome Conſiderations occaſionally propoſed to a Friend. Page 449
XXV. Tracts, containing *Suſpicions* about ſome *hidden Qualities* of *the Air*; with an Appendix touching *Celeſtial Magnets*, and ſome other Particulars. Animadverſions upon Mr. *Hobbes*'s *Problemata de Vacuo*. A Diſcourſe of the Cauſe of *Attraction* by *Suction*. 458
1. Obſervations about the *Growth* of *Metals* in their *Ore*, expoſed to the Air. 459
2. Suſpicions about ſome *hidden Qualities* in the Air. 463
3. Some additional Experiments relating to the *Suſpicions* about the *hidden Qualities* of the *Air*. 474
4. Animadverſions upon Mr. *Hobbes*'s *Problemata de Vacuo*. 476
5. Of the Cauſes of *Attraction* by *Suction*; a Paradox. 493
XXVI. New Experiments about the *Preſervation* of Bodies *in Vacuo Boyliano*. 504
XXVII. An Account of two Sorts of the *Helmontian Laudanum*, together with the way of the noble Baron *F. M. van Helmont*, (Son to the famous *Johannes Baptiſta*) of preparing his *Laudanum*. 507
XXVIII. Some Conſiderations about the Reconcileableneſs of *Reaſon* and *Religion*, by *T. E.* a Layman. To which is annexed by the Publiſher, A Diſcourſe of Mr. *Boyle* about the Poſſibility of the *Reſurrection*. 509
1. Some Conſiderations about the Reconcileableneſs of *Reaſon* and *Religion*. 513
2. Some *Phyſico-theological* Conſiderations about the Poſſibility of the *Reſurrection*. 537
XXIX. A Conjecture concerning the *Bladders* of *Air* that are found in *Fiſhes*, communicated by *A. J.* and illuſtrated by an Experiment. 546
XXX. A new *Eſſay-Inſtrument*, together with the Uſes thereof. 547
XXXI. New Experiments about the *weakned Spring*, and ſome unobſerved Effects of the *Air*. 553
XXXII. An Experimental Diſcourſe of *Quick-ſilver* growing *hot* with *Gold*. 557
XXXIII. Experiments, Notes, *&c.* about the *mechanical Origin* or *Production* of divers particular *Qualities*; among which is inſerted a Diſcourſe of the Imperfection of the *Chymiſts* Doctrine of *Qualities*, together with ſome Reflections upon the *Hypotheſis* of *Alcali* and *Acidum*. 565
1. Of the mechanical *Origin* of *Heat* and *Cold*. 570
2. A Digreſſion about *Potential* Coldneſs. 572.
3. Experiments and Obſervations about the *mechanical* Production of *Taſtes*. 586
4. A ſhort Excurſion about ſome Changes made of *Taſtes* by *Maturation*. 590
5. Experiments and Obſervations about the *mechanical* Production of *Odours*. 591
6. Of the Imperfections of the *Chymiſts* Doctrine of *Qualities*. 595
7. Reflections upon the Hypotheſis of *Alcali* and *Acidum*. 603
8. Experiments and Notes about the *mechanical* Origin and Production of *Volatility*. 609
9. Experimental Notes of the *mechanical* Origin, or Production of *Fixedneſs*. 619
10. Experiments and Notes about the *mechanical* Origin, or Production of *Corroſiveneſs*. 624
11. About the *mechanical* Origin of *Corroſibility*. 631
12. Of the *mechanical* Cauſes of *Chymical Precipitation*. 635
13. Experiments and Notes about the *mechanical* Production of *Magnetiſm*. 643
14. Experiments and Notes about the *mechanical* Origin, or Production of *Electricity*. 647

The CONTENTS of the FOURTH VOLUME.

I. NEW Experiments about the *ſuperficial* Figures of *Fluids*, eſpecially of *Liquors* contiguous to other *Liquors*. 1
II. A Continuation of the Experiments publiſhed in the next foregoing Tract about *Fluids* contiguous to other *Fluids*. 6
III. A ſhort Memorial of ſome Obſervations made upon an *artificial* Subſtance that *ſhines* without any precedent Illuſtration. 10
IV. An Hiſtorical Account of a *Degradation* of *Gold* made by an *Anti-Elixir*; a ſtrange *chemical* Narrative. 13
V. The *Aërial Noctiluca*, or ſome new *Phænomena*, and a Proceſs of a *factitious ſelf-ſhining* Subſtance. 19
VI. Obſervations made by Mr. *Boyle* about the *Aërial Noctiluca* contained in his ſecond Phial. 24
VII. Additional Obſervations about the *Aërial Noctiluca*. 30
VIII. Of the way of preparing the *Aërial Noctiluca*. 35
IX. A new *Lamp* contriv'd by the Honourable *Robert Boyle* Eſq; 38
X. A Diſcourſe of Things *above Reaſon*, inquiring whether a *Philoſopher* ſhould admit there are any ſuch. To which are annexed by the Publiſher (for the Affinity of the Subjects) ſome Advices about judging of Things ſaid to tranſcend *Reaſon*. 39
1. Advices in judging of Things ſaid to *tranſcend Reaſon*. 54
XI. New Experiments and Obſervations made upon the *icy Noctiluca*; to which is added, A *chymical* Paradox grounded upon new Experiments, making it probable that *chymical* Principles are *tranſmutable*, ſo that out of one of them others may be produced. 70
1. An Appendix to the *Aerial Noctiluca*. 71

2. New Phænomena exhibited by an *Icy Noctiluca*, or ſolid *ſelf-ſhining* Subſtance. Page 74
3. Obſervations about the *Water* wherein the *Noctiluca* was kept. 75
4. Experiments diſcovering a ſtrange Subtilty of Parts in the *Glacial Noctiluca*. 79
5. Obſervations about the *Inflammability* of the *Noctiluca* itſelf. 82
6. Experiments about *burning* other Bodies with the *Noctiluca*. 84
7. A *Chymical Paradox* grounded upon new Experiments, making it probable that *Chymical* Principles are *tranſmutable*; ſo that out of one of them others may be produced. 89

XII. A Continuation of new Experiments *Phyſico-mechanical*, touching the *Spring* and *Weight* of the *Air*, and their Effects. The ſecond Part. Wherein are contained divers Experiments made both in *compreſſed*, and alſo in *factitious Air*, about *Fire*, *Animals*, *&c.* Together with a Deſcription of the *Engines* wherein they were made. 96

XIII. A Letter of Mr. *Boyle*'s to the Learned Dr. *John Beal*, Fellow of the *Royal Society*, concerning *freſh Water* made out of *Sea-water*; printed at the Deſire of the Patentees, in a Tract intitled, *Salt Water ſweetned*, by *R. Fitzgerald. London*, 1683. 4to. 159

XIV. Memoirs for the natural Hiſtory of *human Blood*, eſpecially the *Spirit* of that Liquor; with an Appendix. 161
1. An Appendix to the Memoirs for the Hiſtory of *human Blood*. 196

XV. Experiments about the *Poroſity* of *Bodies*, in two Eſſays, of the *Porouſneſs* of animal Bodies. 206
1. An Eſſay of the Porouſneſs of ſolid Bodies. 219

XVI. Short Memoirs for the *natural* experimental Hiſtory of *mineral Waters*, addreſſed by way of Letter to a Friend. 231

XVII. An Eſſay of the great Effects of even *languid* and *unheeded Motion*; whereunto is annexed an experimental Diſcourſe of ſome little obſerved Cauſes of the *Inſalubrity* and *Salubrity* of the *Air*, and its Effects. [Being Part of an intended natural Hiſtory of the *Air*.] 251
1. A ſhort Supplement to the *Eſſay* of the great Effects of even *languid* and *unheeded local Motion*. 272
2. An experimental Diſcourſe of ſome *unheeded* Cauſes of the *Inſalubrity* and *Salubrity* of the *Air*, being Part of an intended natural Hiſtory of *Air*. 276

XVIII. An hiſtorical Account of a ſtrangely *ſelf-moving Liquor*. 299

XIX. Of the Reconcileableneſs of *ſpecific Medicines* to the *corpuſcular* Philoſophy; to which is annexed a Diſcourſe about the Advantages of the Uſe of *ſimple Medicines*. 301
1. The Advantages of the Uſe of *ſimple Medicines* propoſed by way of Invitation to it. 325

XX. Of the high Veneration *Man's Intellect* owes to *God*, peculiar for his *Wiſdom* and *Power*. 339

XXI. A free Inquiry into the vulgarly received Notion of *Nature*, made in an *Eſſay* addreſſed to a Friend. 358

XXII. The Martyrdom of *Theodora*, and of *Didymus*. 425

XXIII. *Medicinal Experiments*, or a Collection of choice and *ſafe Remedies*, for the moſt part *ſimple*, and eaſily prepared; very uſeful in Families, and fitted for the Service of Country People. The firſt Volume. 464
1. *Medicinal Experiments*, or a Collection of choice and *ſafe Remedies*, very uſeful in all Families. The ſecond Volume. 477
2. A Supplement to Mr. *Boyle*'s Collections of ſafe and *choice Remedies*, taken from his own *Manuſcripts*, added to the fourth Edition, never printed before. 500
3. A Collection of choice and *ſafe Remedies*. The third Volume. 504

XXIV. A Diſquiſition about the *final Cauſes* of *natural* Things, wherein is inquired, whether, and (if at all) with what Cautions a *Naturaliſt* ſhould admit them? To which are ſubjoined, by way of Appendix, ſome uncommon Obſervations about *vitiated Sight*. 515
1. Some uncommon Obſervations about vitiated Sight. 551

The CONTENTS of the FIFTH VOLUME.

I. *Medicina Hydroſtatica*, or *Hydroſtaticks* applied to the *Materia Medica*. Shewing, how by the *Weight* that divers Bodies uſed in *Phyſick* have in *Water*, one may diſcover whether they be *genuine* or *adulterate*. To which is ſubjoined a previous *Hydroſtatical* Way of eſtimating *Ores*. 1
1. A previous *Hydroſtatical* Way of eſtimating *Ores*, addreſſed to the Secretary of the *Royal Society*. 25

II. *The Chriſtian Virtuoſo*, ſhewing that by being addicted to *Experimental Philoſophy* a Man is rather aſſiſted than indiſpoſed to be a good *Chriſtian*. The firſt Part. To which are ſubjoined, I. A Diſcourſe about the *Diſtinction* that repreſents ſome Things as *above Reaſon*, but not *contrary to Reaſon*. II. The firſt Chapters of a Diſcourſe entitled, *Greatneſs of Mind promoted by Chriſtianity*. The firſt Part. 37
1. Reflections upon a *Theological Diſtinction*; according to which, it is ſaid that ſome *Articles of Faith* are *above Reaſon*, but not *againſt Reaſon*, in a Letter to a Friend. 59
2. *Greatneſs of Mind* promoted by *Chriſtianity*, in a Letter to a Friend. The firſt Part. 65
3. *Greatneſs of Mind* promoted by *Chriſtianity*. The ſecond Part. 74

III.

III. *Experimenta & Obſervationes Phyſicæ*; wherein are briefly treated of ſeveral Subjects relating to *natural Philoſophy*, in an *experimental* way; to which is added, a ſmall Collection of *ſtrange Reports*. Page 75
1. Strange Reports, in two Parts, addreſſed to a *Virtuoſo*, Friend to the Author, the firſt Part. 101
IV. The general *Hiſtory* of the *Air* deſigned and begun. 105
V. A Paper of the Honourable *Robert Boyle*'s, depoſited with the Secretaries of the *Royal Society*, *October* 14, 1680. and opened ſince his Death, being an Account of his making the *Phoſphorus*, &c. 198
VI. An Account of the Honourable *Robert Boyle*'s Way of examining *Waters* as to *Freſhneſs* and *Saltneſs*. To be ſubjoined as an Appendix to his lately printed Letter about the *ſweetned Sea-Water*, *October* 30, 1683. 199
VII. A free Diſcourſe againſt *Cuſtomary Swearing*, and a Diſſuaſive from *Curſing*. 204
1. A Diſſuaſive from *Curſing*; from Mr. *W. D.* to Sir *G. L.* 222
VIII. Letters of Mr. *Boyle* to ſeveral Perſons. 229
IX. Letters from ſeveral Perſons to Mr. *Boyle*. 256
X. Appendix to the firſt Part of the *Chriſtian Virtuoſo*. 655
XI. The *Chriſtian Virtuoſo*. The ſecond Part. 685

In the FIRST VOLUME, after the *Life* and *Appendix*, and before the *New Experiments*, are to be inſerted the following Pieces.

I. A Preface by Mr. *Boyle*, to a Tract touching the Skill of a better way of Anatomy of Man's Body, by *Yonker Louis de Bills*, Lord of *Koppenſdam*, &c. tranſlated from the *Low Dutch* by Mr. *Pell*. *London* 1649. in 12mo. 140
II. A Letter prefix'd to the fourth Edition of a Tract tranſlated from the *French* by Dr. *Peter du Moulin*, intitled, *The Devil of Maſcon*. *Oxferden* 1669, in 12mo. 141
III. An Advertiſement of Mr. *Boyle*'s about the Loſs of many of his Writings, addreſſed to *J. W.* to be communicated to thoſe of his Friends that are *Virtuoſi*; which may ſerve as a kind of a Preface to moſt of his mutilated and unfiniſhed Writings. *London* 1688. Fol. 142

A Liſt of the Titles of the MSS. of Mr. BOYLE, not inſerted in the Five Volumes, for the Reaſons mention'd in the Preface.

N. B. Thoſe mark'd with an * Aſteriſc are miſſing.

THEOLOGICAL.

1. Conſiderations about ſome of the Cauſes of Atheiſm.
2. Four Conferences about as many grand Objections made by Philoſophical Wits againſt the Chriſtian Faith.
3. An Invitation to endeavour the Converſion of Infidels, to which is annexed the good Offices Revelation does to Reaſon.
4. A ſhort Diſcourſe, ſhewing that the great Diverſity of Religions ought not much to ſtagger a well-grounded Chriſtian.
5. Some Conſiderations about Miracles, as made uſe of as Proofs for the Chriſtian Religion.
6. Memorials to the introductory Preamble for Mr. *Boyle*'s Theological Tracts.
7. Imperfection of human Reaſon diſcover'd by its own Light. A Dialogue.
8. Mutual good Offices, that Reaſon and Revelation do each other.
9. Whether Theology and Philoſophy contradict each other.
10. Excellency of Chriſtianity.
11. Eſſay on the Scripture. *N. B.* From this the Conſiderations touching the Style of the Scriptures were partly ſelected.
12. On Meditation.
13. Duty of a Mother to nurſe her own Child.
14. The Daily Reflector, to Lady *Ranelagh*.
15. An Eſſay to ſhew in what ſenſe Reaſon is, and in what it is not contrary to Revelation. A Dialogue.
*16. Whether true Miracles do ſo much repeal, or overthrow the Courſe of Nature, as is wont to be believ'd.
17. Papers on the Martyrdom of *Theodora*, &c. never printed.
18. Eſſays on Ethicks, three Books. 1645.
19. Eſſays on Sin and Piety, &c.

PHILOSOPHICAL.

1. Several Centuries of Experiments and Obſervations.
2. A ſecond and third Part of *Experimenta & Obſervationes Phyſicæ*.

3. Chymiſtry, its Uſefulneſs to human Life—to Trades, *&c.*
4. Hiſtory of Colours.
5. Hiſtory of human Blood, an Appendix to the publiſh'd Tract.
6. A Philoſophical Chaos.
7. Chymico-Medical Chaos.
8. Uſes and Bounds of Experience in natural Philoſophy.
9. The Utility of Experiments ſpeculative and active.
10. *Cogitationes Phyſicæ Miſcellaneæ.*
11. Of compiling a Natural Hiſtory; the Imperfection of—the Uſefulneſs of, *&c.*
12. Natural Hiſtory of Tin, *&c.* of Air.
13. Of Fire and Flame, of the Fuel of the Sun's Fire, Mechanical Origin of Inflammability.
14. Elementary Bodies.
*15. Origin of Minerals and Metals—Conferences about Tranſmutation and Melioration of Metals.
16. Of Poiſons, and of turning them into Antidotes.
17. Of Pores of Bodies, Obſervations and Figures of Corpuſcles, *&c.*
18. Requiſites of a good Hypotheſis.
19. *Materia Medica*, a ſecond Tome.
20. A practical Eſſay about parable Medicines.
*21. A Collection of parable Medicines.
*22. * for the Eyes.
23. Of Specifics, tending to ſhew they are not inconſiſtent with mechanical Philoſophy.
24. An Invitation to Phyſicians to make uſe of ſimple Medicines.
25. A Chemical and Mechanical Examen of *Materia Medica.*
26. Paradoxes about Phlegms.
27. Seminal Principles.
28. Seeds of Plants, Animals, *&c.*
29. Hydroſtatics, being an Appendix to Hydroſtatic Paradoxes.
30. Examen of one Cauſe of the Magnetiſm of the Earth.
*31. The Sceptical Naturaliſt.
*32. Conſiderations touching occult Qualities.
*33. On ſpontaneous Generation.
34. Strange Reports; concerning the ſecond Sight, Relations communicated.
35. A large Collection of Things learn'd by converſing with Sea-Captains, Pilots, *&c.* who have traded to the *Indies*, Eaſt and Weſt, to *Hudſon's Bay*, *&c.*
36. MS. Copies of many of his Tracts turn'd into *Latin.*
37. A great number of Letters from learned Perſons abroad in *Latin*, *French*, *Italian*, *Dutch*, *&c.* The Number of Letters of all ſorts, printed and unprinted, beſides many ſuppoſed to be loſt, amounts to 1500, and more.

N. B. There are many ſubordinate Titles of Tracts, comprehended under the more general ones above-mention'd, both Theological and Philoſophical, omitted for the ſake of Brevity.

ERRATA & ADDENDA.

In the *Life.*

P. 17. l. 55. for *diſcountenance* read *diſcontinuance.*
p. 28. l. 34. for *power* read *powder.*
ibid. l. 60. for *in country* read *in one country.*

Appendix to the *Life.*

p. 107. l. 45. after the word *intended* add *charity.*

VOL. I.

p. 108. *a.* l. 44. for *exceed* 30 *inches*, read *exceed* not 30 *inches.*
p. 170. *a.* l. 2. for *degrees* read *decrees.*
p. 179. *a.* l. 38. for *affection* read *affliction.*
p. 181. *a.* l. 12. after *objects* add, *but ſhall be heightened and improved.*
p. 241. *a.* l. 2. after *practical* add *account.*
p. 263. *b.* l. 20. for *conſtant* read *conſiſtent.*
p. 300. *b.* l. 23. for *poſſible* read *impoſſible.*

VOL. III.

p. 31. Exper. xxiii. for *ſuſpended higher at the* top, read *bottom*; and for *bottom*, read *top.*
p. 31. *a.* l. 55. for *higher* read *lower.*

VOL. V.

p. 38. l. 55. for *appoint* read *diſappoint.*
p. 199. *a.* l. 30. to the word *friend* add an aſteriſc *.
ibid. marg. note, for *paſſage* read *paper.*
p. 230. *b.* at the bottom, the letter ſhould be inſcrib'd to Mr. *Oldenburg.*
p. 234. *b.* add in the margin at the top, *Vid. p.* 610. *a.*
p. 245. *a.* againſt the words, *To Mr. Glanvil*, add, *Vid. p.* 628.
p. 316. *a.* l. 46, 47. for *Oldenburg* read *Boyle.*
p. 418. *a.* l. 33. for *may* be, read *may* do.
p. 610. add in the margin at the top, *Vid. p.* 234. *b.*
p. 628. againſt *Bath*, *Oct.* 7. add in the margin, *Vid. p.* 245. *a.*
p. 648. *b.* l. 12. dele *a being.*
p. 657. *b.* in the margin near the bottom dele *Derham's Aſtro-Theol.*
p. 661. *a.* l. 34. before the Words *I do not wonder*, place *Juſtinus.*
p. 662. *a.* l. 2. dele Argument I. in the margin, and place the ſame in the margin below againſt l. 30.
ibid. a. l. 32. for *perfect* read *imperfect.*
p. 669. *a.* l. 18, 19. after the word *incomprehenſible*, add, *But here experience again aſſiſts us, and that by more ways than one.*
p. 674. *a.* l. 48. for *affirmative* read *negative.*
p. 675. *a.* l. 29. for *contracted* read *contradicted.*

Directions to the Binder.

The Fifteen Folio Copper-Plates are to be placed at the End of the Volumes, to which they reſpectively belong.

NEW

EXPERIMENTS PHYSICO-MECHANICAL,

Touching

The SPRING of the AIR, and its EFFECTS;

Made, for the moſt part, in a New

PNEUMATICAL ENGINE.

Written by way of LETTER

To the Right Honourable *CHARLES* Lord Viſcount of *DUNGARVAN*,

Eldeſt Son to the EARL of *CORKE*.

To the Reader.

ALTHOUGH the following treatiſe being far more prolix than becomes a letter, and than I at firſt intended it, I am very unwilling to encreaſe the already exceſſive bulk of the book by a preface; yet there are ſome particulars, that I think my ſelf obliged to take notice of to the reader, as things that will either concern him to know, or me to have known.

IN the firſt place then: If it be demanded why I publiſh to the world a letter, which, by its ſtyle and divers paſſages, appears to have been written as well for, as to a particular perſon; I have chiefly theſe two things to anſwer: the one, that the experiments therein related, having been many of them tried in the preſence of ingenious men, and by that means having made ſome noiſe among the Virtuoſi (inſomuch that ſome of them have been ſent into foreign countries, where they have had the luck not to be deſpiſed) I could not, without quite tiring more than one amanuenſis, give out half as many copies of them as were ſo earneſtly deſired, that I could not civilly refuſe them. The other, that intelligent perſons in matters of this kind perſuade me, that the publication of what I had obſerved touching the nature of the air, would not be uſeleſs to the world; and that in an age ſo taken with novelties as is ours, theſe new experiments would be grateful to the lovers of free and real learning: ſo that I might at once comply with my grand deſign of promoting experimental and uſeful philoſophy, and obtain the great ſatisfaction of giving ſome to ingenious men; the hope of which is, I confeſs, a temptation, that I cannot eaſily reſiſt.

OF my being ſomewhat prolix in many of my experiments, I have theſe reaſons to render; that ſome of them being altogether new, ſeemed to need the being circumſtantially related, to keep the reader from diſtruſting them: that divers circumſtances I did here and there ſet down for fear of forgetting them, when I may hereafter have occaſion to make uſe of them in my other writings: that in divers caſes I thought it neceſſary to deliver things circumſtantially, that the perſon I addreſſed them to might, without miſtake, and with as little trouble as is poſſible, be able to repeat ſuch unuſual experiments: and that after I conſented to let my obſervations be made publick, the moſt ordinary reaſon of my prolixity was, that foreſeeing, that ſuch a trouble as I met with in making thoſe trials carefully, and the great expence of time that they neceſſarily require (not to mention the charges of making the engine, and employing a man to manage it) will probably keep moſt men from trying again theſe expeirments, I thought I might do the generality of my readers no unacceptable piece of ſervice, by ſo punctually relating what I carefully obſerved, that they may look upon theſe narratives as ſtanding records in our new pneumaticks, and need not reiterate themſelves an experiment to have as diſtinct an idea of it, as may ſuffice them to ground their reflexions and ſpeculations upon.

AND becauſe ſometimes 'tis the diſcourſe made upon the experiment, that makes it appear

prolix, I have commonly left a conſpicuous interval betwixt ſuch diſcourſes, and the experiments whereunto they belong, or are annexed; that they, who deſire only the hiſtorical part of the account we give of our engine, may read the narratives, without being put to the trouble of reading the reflexions too; which I here take notice of, for the ſake of thoſe, that are well verſed in the new philoſophy and in the mathematicks; that ſuch may ſkip what was deſigned but for ſuch perſons as may be leſs acquainted, even than I, with matters of this nature (ſcarce ſo much as mentioned by any writer in our language) and not for them, from whom I ſhall be much more forward to learn, than to pretend to teach them. Of my being wont to ſpeak rather doubtfully, or heſitantly, than reſolvedly, concerning matters wherein I apprehend ſome difficulty, I have in another treatiſe (which may, through God's aſſiſtance, come abroad ere long) given a particular, and, I hope, a ſatisfactory account: wherefore I ſhall now defend my practice but by the obſervation of *Ariſtotle*, who ſomewhere notes, that to ſeem to know all things certainly, and to ſpeak poſitively of them, is a trick of bold and young fellows; whereas thoſe, that are indeed intelligent and conſiderate, are wont to employ more wary and diffident expreſſions, or (as he ſpeaks) προσ-τιθέασιν ἀεὶ τὸ ἴσως ἢ τὸ τάχα.

THERE are divers reflexions, and other paſſages in the following epiſtle, and even ſome experiments (occaſionally mentioned) which may ſeem either impertinent or ſuperfluous, but are not ſo; being purpoſely written, either to evince ſome truth oppoſed, or diſprove ſome erroneous conceit maintained by ſome eminent new philoſopher, or by ſome other ingenious men, who, I preſumed, would eaſily forgive me the having on ſuch occaſions purpoſely omitted their names; though an inquiſitive perſon will probably diſcover divers of them, by the mention of the opinions diſprov'd in the experiments I am excuſing.

EVER ſince I diſcerned the uſefulneſs of ſpeculative geometry to natural philoſophy, the unhappy diſtempers of my eyes have ſo far kept me from being much converſant in it, that I fear I ſhall need the pardon of my mathematical readers for ſome paſſages, which, if I had been deeply ſkill'd in geometry, I ſhould have treated more accurately.

AND indeed, having, for reaſons elſewhere deduced, purpoſely kept my ſelf a ſtranger to moſt of the new hypotheſes in philoſophy, I am ſenſible enough, that the engine I treat of hath prevailed with me to write of ſome ſubjects, which are ſufficiently remote from thoſe I have been moſt converſant in. And having been reduced to write the greateſt part of the enſuing letter at a diſtance, not only from my library, but from my own manuſcripts, I cannot but fear, that my diſcourſes do not only want many choice things, wherewith the learned writings of others might have enriched or imbelliſhed them; but that partly for this reaſon, and partly for that touched upon a little before, it is poſſible I may have mentioned ſome notions already publiſhed by others, without taking notice of the authors, not out of any deſign to defraud deſerving men, but for want of knowing ſuch particulars to have been already publiſhed by them; eſpecially the experiments of our engine being themſelves ſufficient to hint ſuch notions as we build upon them.

THE order of the experiments every reader may alter, as ſuits beſt with his own deſign in peruſing them: for not only all thoſe, betwixt whom there is an affinity in nature (by belonging to one ſubject) are not always placed one by another, but they are not ſtill ſet down ſo much as in the order wherein they were made; but moſt commonly in that caſual one, wherein my occaſions induced me to diſpatch them to the preſs. And, which is worſe, I did uſually ſend quite away the former experiments, before the later were written, or perhaps ſo much as made: whereby I loſt the advantage of correcting and ſupplying the imperfections of what I had formerly written, by the light of my ſubſequent trials and diſcoveries.

BESIDES all this, the diſtemper in my eyes forbidding me not only to write my ſelf ſo much as one experiment, but even to read over my ſelf what I dictated to others; I cannot but fear, that beſides the author's miſtakes, this edition may be blemiſhed by many, that may be properly imputed to a very unſkilful writer (whom I was oftentimes by haſte reduced, againſt my cuſtom, to imploy) and may have eſcaped the diligence of that learned friend, that doth me the favour to overſee the preſs; eſpecially, there being the diſtance of two days journey betwixt it and me.

I NEED not, perhaps, repreſent to the equitable reader, how much the ſtrange confuſions of this unhappy nation, in the midſt of which I have made and written theſe experiments, are apt to diſturb that calmneſs of mind and undiſtractedneſs of thoughts, that are wont to be requiſite to happy ſpeculations. But I preſume, that by all theſe things put together, he will readily perceive, that I have been ſo far from following the poet's prudent counſel touching the ſlow publication of books deſigned to purchaſe credit by,

——*nonumque prematur in annum,*

that I ſuffer this treatiſe to come abroad into the world with a multitude of diſadvantages.

BUT if it be demanded, why then I did not make it fitter for the preſs, before I ſent it thither? my anſwer muſt be, that not at firſt imagining, that this ſort of experiments would prove any thing near ſo troubleſome, either to make, or to record, as I afterwards found them, I did, to engage the printer to diſpatch, promiſe him to ſend him the whole epiſtle in a very ſhort time. So that although now and then the occaſional vacations of the preſs, by reaſon of feſtivals, or the abſence of the corrector, gave me the leiſure to exſpatiate upon ſome ſubject; yet being oftentimes called upon

to

to diſpatch the papers to the preſs, my promiſe, and many unexpected avocations, obliged me to a haſte, which, though it hath detracted nothing from the faithfulneſs of the hiſtorical part of our book, hath (I fear) been diſadvantageous enough to all the reſt. And I made the leſs ſcruple to let the following papers paſs out of my hands, with all their imperfections, becauſe, as the publick affairs, and my own, were then circumſtanced, I knew not when, (if at all) I ſhould be again in a condition to proſecute experiments of this kind; eſpecially, ſince (to omit my being almoſt weary of being, as it were, confined to one ſort of experiments) I am pre-engaged (if it pleaſe God to vouchſafe me life and health) to imploy my firſt leiſure in the publication of ſome other phyſiological papers, which I thought it would make me much the fitter to take in hand, if I firſt diſpatched all that I had at this time to write touching our engine.

I HAVE this farther to add, by way of excuſe, that as it hath been my deſign in publiſhing theſe experiments to gratify ingenious men; ſo, if I have not been much flattered, I may hope, that the various hints to be met with in the following letter will (at leaſt) ſomewhat awaken mens thoughts, and excite them to new ſpeculations, (ſuch as perhaps even inquiſitive men would ſcarce elſe light upon;) and I need not deſpair, that even the examination of ſuch new ſuſpicions and enquiries will hence alſo, at leaſt occaſionally, be facilitated: I ſaid occaſionally, becauſe it being, as it is proverbially ſaid, *facile inventis addere*; it ſeems not irrational to expect, that our engine it ſelf, and divers of our experiments, will be much promoted by the induſtry of inventive and mathematical wits, whoſe contrivances may eaſily either correct or ſupply, and conſequently ſurpaſs many of thoſe we have made uſe of. And, particularly, if men by ſkill and patience can arrive both to evacuate ſuch receivers as ours, till there be no more air left in them, than there ſeems to have remained in the glaſſes made uſe of about the Magdeburgick experiment (hereafter to be mentioned) and to keep out the air for a competent while, the uſefulneſs and diſcoveries of our engine will not be a little advanced. And perhaps that may belong to it, which I remember *Seneca* ſpeaks of nature; *initiatos* (ſaith he) *nos credimus, in veſtibulo ejus hæremus.* For being now in a place, where we are not quite deſtitute of moderately ſkilful artificers, we have, ſince the concluſion of the following letter, made ſome additions to our engine, by whoſe help we find (upon ſome new trials) that we may be able, without much of new trouble, to keep the ambient air out of the exhauſted receiver for a whole day. And perhaps we ſhould be able to keep it out much longer, if before we ſhall have diſpatched ſome urgent affairs, and publiſhed ſome papers, for which a kind of promiſe is thought to make us debtors to the preſs, we could be at leiſure to proſecute ſuch experiments, as may poſſibly afford a ſupplement to the following treatiſe, from which I ſhall now no longer detain the reader.

Friendly Reader,

I KNOW all perſons, that have a publick ſpirit for the advancement of learning, will think much, that this piece came not out in a language of more general uſe, than this you ſee it now attired in; eſpecially ſince the excellent noble perſon, who is the author, is known to be well able himſelf (being almoſt univerſally a linguiſt) to have given it either the old Latin, or the newer French dreſs.

BUT if it be an honour to a language to be preferred, and this honour breeds ſometimes an emulation, as anciently it did between the Greeks and Romans, it cannot be thought unhandſome for an Engliſh nobleman to have preferred his own: and it may be a ſufficient reaſon for the gentry of foreign parts to learn our ſpeech, or keep interpreters, that they are ſure to have for their requital, from many of our Engliſh writers (as here from this piece) much curiouſly ingenious and profitable learning.

BUT as to this particular, (give me leave to uſe words from a ſtory;) Since the mountain cannot come to *Mahomet*, *Mahomet* will go to the mountain: I mean thus; becauſe many witty men, perſons of honour and eſtate eſpecially, may be ſuppoſed to be able to make a better account, by employing their ſtudies and time on matter than words, and ſo are juſtly impeded from learning languages; and becauſe (as I may judge) the noble author is willing to oblige all men, he hath already provided, that this piece ſhall ſhortly be done into Latin, that ſo it may come home to divers worthy perſons in its ſtream, who cannot travel to find it out in its firſt origin.

HAVING therefore leave ſo to do, I cannot forbear to give the world the advertiſement of this Latin edition, leſt ſome ſkilful artiſt ſhould take needleſs pains about a work, which will ere long (by God's furtherance) be done to his hands. For ſuch unprofitable expences of ſtudy have too frequently happened, and too much to the diſadvantage of learning, for want of a ſufficient correſpondence and intercourſe between ſuch as are exerciſed in the mines of wiſdom.

THIS is all the trouble I ſhall at preſent give you: nor ſhall I need mind you, if you have a true guſt for the book you read, to have an honour and thankful regard to the perſon, that hath favoured us with the communication of theſe his trials, and is manifeſtly ſo great a patron and friend to experimental learning, and all true wiſdom: for ſhould you fail in this, you might deſervedly be deprived of ſome other obſervations on the ſame ſubject, which the author, I hear, hath made ſince the finiſhing of this treatiſe.

I DESIRE to be excuſed, that I do not make excuſes for the ſlowneſs of the publication, hoping that the long expectation you have had of it, will enhance, and not diminiſh your delight in the enjoyment of a piece like to be, amongſt the ſtudents in accurate philoſophy, of ſo general acceptance. Farewell.

R. Sh.

TO THE

LORD of *DUNGARVAN*, my Honoured and Dear NEPHEW.

My Dear Lord,

RECEIVING in your laſt from *Paris* a deſire, that I would add ſome more experiments to thoſe I formerly ſent you over; I could not be ſo much your ſervant as I am, without looking upon that deſire as a command; and conſequently, without thinking myſelf obliged to conſider by what ſort of experiments it might the moſt acceptably be obeyed. And at the ſame time, perceiving by letters from ſome other ingenious perſons at *Paris*, that ſeveral of the Virtuoſi there were very intent upon the examination of the intereſt of the air, in hindering the deſcent of the quick-ſilver, in the famous experiment touching a vacuum; I thought I could not comply with your deſires in a more fit and ſeaſonable manner, than by proſecuting and endeavouring to promote that noble experiment of *Torricellius*; and by preſenting your Lordſhip an account of my attempts to illuſtrate a ſubject, about which its being ſo much diſcourſed of where you are, together with your inbred curioſity, and love of experimental learning, made me ſuppoſe you ſufficiently inquiſitive.

AND though I pretend not to acquaint you, on this occaſion, with any ſtore of new diſcoveries, yet poſſibly I ſhall be ſo happy, as to aſſiſt you to know ſome things, which you did formerly but ſuppoſe; and ſhall preſent you, if not with new theories, at leaſt with new proofs of ſuch as are not yet become unqueſtionable. And if what I ſhall deliver hath the good fortune to encourage and aſſiſt you to proſecute the hints it will afford, I ſhall account my ſelf, in paying of a duty to you, to have done a piece of ſervice to the commonwealth of learning. Since it may highly conduce to the advancement of that experimental philoſophy, the effectual purſuit of which requires as well a purſe as a brain, to indear it to hopeful perſons of your quality, who may accompliſh many things, which others can but wiſh, or at moſt but deſign, by being able to imploy the preſents of fortune in the ſearch of the myſteries of nature.

AND I am not faintly induced to make choice of this ſubject, rather than any of the expected chymical ones, to entertain your Lordſhip upon, by theſe two conſiderations: the one, that the air being ſo neceſſary to human life, that not only the generality of men, but moſt other creatures that breathe, cannot live many minutes without it, any conſiderable diſcovery of its nature ſeems likely to prove of moment to mankind. And the other is, that the ambient air being that, whereto both our own bodies, and moſt of the others we deal with here below, are almoſt perpetually contiguous, not only its alterations have a notable and manifeſt ſhare in thoſe obvious effects, that men have already been invited to aſcribe thereunto, (ſuch as are the various diſtempers incident to human bodies, eſpecially if crazy in the ſpring, the autumn, and alſo on moſt of the great and ſudden changes of weather;) but likewiſe, the further diſcovery of the nature of the air will probably diſcover to us, that it concurs more or leſs to the exhibiting of many phænomena, in which it hath hitherto ſcarce been ſuſpected to have any intereſt. So that a true account of any experiment that is new concerning a thing, wherewith we have ſuch conſtant and neceſſary intercourſe, may not only prove of ſome advantage to human life, but gratify philoſophers, by promoting their ſpeculations on a ſubject, which hath ſo much opportunity to ſollicit their curioſity.

AND I ſhould immediately proceed to the mention of my experiments, but that I like too well that worthy ſaying of the naturaliſt *Pliny*, *benignum eſt & plenum ingenui pudoris, fateri per quos profeceris*, not to conform to it, by acquainting your Lordſhip, in the firſt place, with the hint I had of the engine I am to entertain you with. You may be pleaſed to remember, that a while before our ſeparation in *England*, I told you of a book, that I had heard of, but not peruſed, publiſhed by the induſtrious Jeſuit *Schottus*; wherein, it was ſaid, he related how that ingenious gentleman, *Otto Gericke*, conſul of *Magdeburg*, had lately practiſed in *Germany*, a way of emptying glaſs veſſels, by ſucking out the air at the mouth of the veſſel, plunged under water. And you may alſo perhaps remember, that I expreſſed my ſelf much delighted with this experiment, ſince thereby the great force of the external air (either ruſhing in at the opened orifice of the emptied veſſel, or violently forcing up the water into it) was

In Præfat. lib. 1.

rendered more obvious and conſpicuous than in any experiment that I had formerly ſeen. And though it may appear by ſome of thoſe writings I ſometimes ſhewed your Lordſhip, that I had been ſolicitous to try things upon the ſame ground; yet in regard this gentleman was before-hand with me in producing ſuch conſiderable effects by means of the exſuction of air, I think my ſelf obliged to acknowledge the aſſiſtance and encouragement the report of his performances hath afforded me.

BUT, as few inventions happen to be at firſt ſo compleat, as not to be either blemiſhed with ſome deficiencies needful to be remedied, or otherwiſe capable of improvement; ſo when the engine, we have been ſpeaking of, comes to be more attentively conſidered, there will appear two very conſiderable things to be deſired in it. For firſt, the wind-pump (as ſomebody not improperly calls it) is ſo contrived, that to evacuate the veſſel, there is required the continual labour of two ſtrong men for divers hours. And next (which is an imperfection of much greater moment) the receiver, or glaſs to be emptied, conſiſting of one entire and uninterrupted globe and neck of glaſs; the whole engine is ſo made, that things cannot be conveyed into it, whereon to try experiments: ſo that there ſeems but little (if any thing) more to be expected from it, than thoſe very few phænomena, that have been already obſerved by the author, and recorded by *Schottus*. Wherefore to remedy theſe inconveniences, I put both Mr. *G.* and *R. Hook* (who hath alſo the honour to be known to your Lordſhip, and was with me when I had theſe things under conſideration) to contrive ſome air-pump, that might not, like the other, need to be kept under water (which on divers occaſions is convenient) and might be more eaſily managed: and after an unſucceſsful trial or two of ways propoſed by others, the laſt named perſon fitted me with a pump, anon to be deſcribed. And thus the firſt imperfection of the German engine was in good meaſure, though not perfectly remedied: and to ſupply the ſecond defect, it was conſidered, that it would not perhaps prove impoſſible to leave in the glaſs to be emptied a hole large enough to put in a man's arm cloathed; and conſequently other bodies, not bigger than it, or longer than the inſide of the veſſel. And this deſign ſeemed the more hopeful, becauſe I remembered, that having ſeveral years before often made the experiment *de vacuo* with my own hands; I had, to examine ſome conjectures that occurred to me about it, cauſed glaſſes to be made with a hole at that end, which uſes to be ſealed up, and had nevertheleſs been able, as occaſion required, to make uſe of ſuch tubes, as if no ſuch holes had been left in them, by deviſing ſtopples for them, made of the common plaiſter called diachylon; which, I rightly enough gueſſed, would, by reaſon of the exquiſite commixtion of its ſmall parts, and cloſeneſs of its texture, deny all acceſs to the external air. Wherefore, ſuppoſing that by the help of ſuch plaiſters carefully laid upon the commiſſures of the ſtopple and hole to be made in the receiver, the external air might be hindered from inſinuating it ſelf between them into the veſſel, we cauſed ſeveral ſuch glaſſes, as you will find deſcribed a little lower, to be blown at the glaſs-houſe. And though we could not get the workmen to blow any of them ſo large, or of ſo convenient a ſhape as we would fain have had; yet finding one to be tolerably fit, and leſs unfit than any of the reſt, we were content to make uſe of it in that engine; of which, I ſuppoſe, you by this time expect a deſcription, in order to the recital of the phænomena exhibited by it.

To give your Lordſhip then, in the firſt place, ſome account of the engine itſelf; it conſiſts of two principal parts; a glaſs veſſel, and a pump to draw the air out of it.

THE former of theſe (which we, with the glaſs-men, ſhall often call a receiver, for its affinity to the large veſſels of that name, uſed by chymiſts) conſiſts of a glaſs with a wide hole at the top, of a cover to that hole, and of a ſtop-cock faſtened to the end of the neck, at the bottom.

THE ſhape of the glaſs, you will find expreſſed in the firſt figure of the annexed ſcheme. And for the ſize of it, it contained about 30 wine quarts, each of them containing near two pound (of 16 ounces to the pound) of water. We ſhould have been better pleaſed with a more capacious veſſel; but the glaſs-men profeſſed themſelves unable to blow a larger, of ſuch a thickneſs and ſhape as was requiſite to our purpoſe.

AT the very top of the veſſel A, you may obſerve a round hole, whoſe diameter B C is of about four inches; and whereof the orifice is incircled with a lip of glaſs, almoſt an inch high: for the making of which lip, it was requiſite (to mention that upon the by, in caſe your Lordſhip ſhould have ſuch another engine made for you) to have a hollow and tapering pipe of glaſs drawn out, whereof the orifice above mentioned was the baſis; and then to have the cone cut off with an hot iron, within about an inch of the points B, C.

THE uſe of the lip is to ſuſtain the cover delineated in the ſecond figure; where D E points out a braſs ring, ſo caſt, as that it doth cover the lip B C of the firſt figure, and is cemented on, upon it, with a ſtrong and cloſe cement. To the inward tapering orifice of this ring (which is about three inches over) are exquiſitely ground the ſides of the braſs ſtopple F G; ſo that the concave ſuperficies of the one, and the convex of the other, may touch one another in ſo many places, as may leave as little acceſs, as poſſible, to the external air. And in the midſt of this cover is left a hole H I, of about half an inch over, invironed alſo with a ring or ſocket of the ſame metal, and fitted likewiſe with a braſs ſtopple K made in the form of the key of a ſtop-cock, and exactly ground into the hole H I it is to fill; ſo as that, though it be turned round in the cavity it poſſeſſes, it will

not let in the air, and yet may be put in or taken out at pleaſure, for uſes to be hereafter mentioned. In order to ſome of which, it is perforated with a little hole 8, traverſing the whole thickneſs of it at the lower end; through which, and a little braſs ring L faſtened to one ſide (no matter which) of the bottom of the ſtopple F G, a ſtring 8, 9, 10, might paſs, to be employed to move ſome things in the capacity of the emptied veſſel, without any where unſtopping it.

THE laſt thing belonging to our receiver is the ſtop-cock, deſigned in the firſt figure by N, for the better faſtening of which to the neck, and exacter excluſion of the air, there was ſodered on to the ſhank of the cock X a plate of tin M T U W, long enough to cover the neck of the receiver. But becauſe the cementing of this was a matter of ſome difficulty, it will not be amiſs to mention here the manner of it; which was, that the cavity of the tin plate was filled with a melted cement, made of pitch, roſin, and wood-aſhes, well incorporated; and to hinder this liquid mixture from getting into the orifice Z of the ſhank X, that hole was ſtopped with a cock, to which was faſtened a ſtring, whereby it might be pulled out at the upper orifice of the receiver; and then, the glaſs neck of the receiver being well warmed was thruſt into this cement, and over the ſhank, whereby it was effected, that all the ſpace betwixt the tin plate and the receiver, and betwixt the internal ſuperficies of the receiver and the ſhank of the cock, was filled with the cement. And ſo we have diſpatched the firſt upper part of the engine.

THE undermoſt remaining part conſiſts of a frame, and of a ſucking-pump, or, as we formerly called it, an air-pump, ſupported by it. The frame is of wood, ſmall but very ſtrong, conſiſting of three legs, 1, 1, 1, ſo placed, that one ſide of it may ſtand perpendicular, that the free motion of the hand may not be hindered. In the midſt of which frame is tranſverſly nailed a board 2, 2, 2, which may not improperly be called a midriff; upon which reſts, and to which is ſtrongly faſtened, the main part of the pump it ſelf, which is the only thing remaining to be deſcribed.

THE pump conſiſts of four parts, a hollow cylinder, a ſucker, a handle to move that ſucker, and a valve.

THE cylinder was (by a pattern) caſt of braſs; it is in length about 14 inches, thick enough to be very ſtrong, notwithſtanding the cylindrical cavity left within it: this cavity is about three inches diameter, and makes as exact a cylinder as the artificer was able to bore. This hollow cylinder is fitted with a ſucker 4, 4, 5, 5, conſiſting of two parts; the one 4, 4, ſomewhat leſs in diameter than the cavity of the cylinder; upon which is nailed a good thick piece of tanned ſhoe-leather, which will go ſo cloſe to the cylinder, that it will need to be very forcibly knocked and rammed in, if at any time it be taken out: which is therefore done, that it may the more exactly hinder the air from inſinuating itſelf betwixt it and the ſides of the cylinder whereon it is to move.

To the midſt of this former part of the ſucker is ſtrongly faſtened the other; namely, a thick and narrow plate of iron 5, 5, ſomewhat longer than the cylinder; one of whoſe edges is ſmooth, but at the other edge it is indented (as I may ſo ſpeak) with a row of teeth, delineated in the ſcheme, into whoſe intervals are to be fitted the teeth of a ſmall iron nut $\alpha\ \beta$ (as tradeſmen call it) which is faſtened by two ſtaples 2, 2, to the under ſide of the formerly mentioned tranſverſe board 2, 2, 2, on which the cylinder reſts, and is turned to and fro by the third piece of this pump, namely the handle or *manubrium* 7, of which the figure gives a ſufficient deſcription.

THE fourth and laſt part of this cylinder is the valve R, conſiſting of a hole bored through at the top of the cylinder, a little tapering towards the cavity; into which hole is ground a tapering peg of braſs, to be thruſt in and taken out at pleaſure.

THE engine being thus deſcribed, it will be requiſite to add, that ſomething is wont to be done before it be ſet on work, for the more eaſy moving of the ſucker, and for the better excluſion of the outward air; which, when the veſſel begins to be exhauſted, is much more difficult to be kept out, than one would eaſily imagine.

THERE muſt then be firſt poured in at the top of the receiver a little ſallad oil, partly to fill up any ſmall intervals, that may happen to be betwixt the contiguous ſurfaces of the internal parts of the ſtop-cock; and partly that it may be the more eaſy to turn the key S, backwards and forwards. Pretty ſtore of oil muſt alſo be poured into the cylinder, both that the ſucker may ſlip up and down in it the more ſmoothly and freely, and that the air might be the better hindered from getting in between them. And for the like reaſons, a little oil is to be uſed alſo about the valve. Upon which occaſion, it would not be omitted (for it is ſtrange) that oftentimes, when neither the pouring in of water, nor even of oil alone, proved capable to make the ſucker move eaſily enough in the cylinder; a mixture of both thoſe liquors would readily (ſometimes even to admiration) perform the deſired effect. And laſtly, the braſs cover of the receiver being put into the braſs ring formerly deſcribed, that no air may get between them, it will be very requiſite to plaiſter over very carefully the upper edges of both with the plaiſter formerly mentioned, or ſome other as cloſe, which is to be ſpread upon the edges with an hot iron; that, being melted, it may run into and fill up all the crannies, or other little cavities, at which the air might otherwiſe get entrance.

ALL things being thus fitted, and the lower ſhank O of the ſtop-cock being put into the upper orifice of the cylinder, and into which it was exactly ground; the experimenter is firſt, by turning the handle, to

force the ſucker to the top of the cylinder, that there may be no air left in the upper part of it. Then ſhutting the valve with the plug, and turning the other way, he is to draw down the ſucker to the bottom of the cylinder; by which motion of the ſucker, the air that was formerly in the cylinder being thruſt out, and none being permitted to ſucceed in its room, it is manifeſt, that the cavity of the cylinder muſt be empty in reference to the air. So that if thereupon the key of the ſtop-cock be ſo turned, as that through the perforation of it a free paſſage be opened betwixt the cylinder and the receiver, part of the air formerly contained in the receiver will nimbly deſcend into the cylinder. And this air being, by the turning back of the key, hindered from the returning into the receiver, may, by the opening of the valve, and forcing up of the ſucker to the top of the cylinder again, be driven out into the open air. And thus by the repetition of the motion of the ſucker upward and downward, and by opportunely turning the key, and ſtopping the valve, as occaſion requires, more or leſs air may be ſucked out of the receiver, according to the exigency of the experiment, and the intention of him that makes it.

YOUR Lordſhip will, perhaps, think, that I have been unneceſſarily prolix in this firſt part of my diſcourſe: but if you had ſeen how many unexpected difficulties we found to keep out the external air, even for a little while, when ſome conſiderable part of the internal had been ſucked out, you would peradventure allow, that I might have ſet down more circumſtances than I have, without ſetting down any, whoſe knowledge, he that ſhall try the experiment, may not have need of. Which is ſo true, that, before we proceed any further, I cannot think it unſeaſonable to adverti ſe you Lordſhip, that there are two chief ſorts of experiments, which we deſign'd in our engine to make trial of: the one, ſuch as may be quickly diſpatched, and therefore may be tried in our engine, though it leak a little, becauſe the air may be faſter drawn out by nimbly plying the pump, than it can get in at undiſcerned leaks; I ſay, at undiſcerned leaks, becauſe ſuch as are big enough to be diſcovered, can ſcarce be uneaſy to be ſtopt. The other ſort of experiments conſiſt of thoſe, that require, not only that the internal air be drawn out of the receiver, but that it be likewiſe for a long time kept out of it. Such are the preſervation of animal and other bodies therein, the germination and growth of vegetables, and other trials of ſeveral ſorts, which it is apparent cannot be well made, unleſs the external air can, for a competent while, be excluded: ſince, even at a very ſmall leak, there may enough get in, to make the vacuum ſoon loſe that name; by which I here declare once for all, that I underſtand not a ſpace, wherein there is no body at all, but ſuch as is either altogether, or almoſt totally devoid of air.

Now this diſtinction of experiments I thought fit to premiſe to the enſuing narratives, becauſe, upon trial, we found it ſo exceeding (and ſcarce imaginably) difficult a matter, to keep out the air from getting at all in at any imperceptible hole or flaw whatſoever, (in a veſſel immediately ſurrounded with the compreſſed atmoſphere,) that in ſpite of all our care and diligence we never were able totally to exhauſt the receiver, or keep it, when it was almoſt empty, any conſiderable time, from leaking more or leſs: although (as we have lately intimated) by unwearied quickneſs in plying the pump, the internal air can be much faſter drawn out than the external can get in, till the receiver come to be almoſt quite empty. And that is enough to enable men to diſcover hitherto unobſerved phænomena of nature.

THE experiments therefore of the firſt ſort will, I fear, prove the only ones, wherewith my avocations will allow me to entertain your Lordſhip in this letter. For till your further commands ſhall engage me to undertake, by God's permiſſion, ſuch an employment, and more leiſure ſhall better fit me for it, I know not whether I ſhall be in a condition to try what may be done, to enable me to give you ſome account of the other ſort of experiments alſo.

EXPERIMENT I.

TO proceed now to the phænomena exhibited to us by the engine above deſcribed; I hold it not unfit to begin with what doth conſtantly and regularly offer it ſelf to our obſervation, as depending upon the fabrick of the engine it ſelf, and not upon the nature of this or that particular experiment, which it is employed to try.

FIRST then, upon the drawing down of the ſucker (the valve being ſhut) the cylindrical ſpace, deſerted by the ſucker, is left devoid of air; and therefore, upon the turning of the key, the air contained in the receiver ruſheth into the emptied cylinder, till the air in both thoſe veſſels be brought to about an equal meaſure of dilatation. And therefore, upon ſhutting the receiver by returning the key, if you open the valve, and force up the ſucker again, you will find, that after this firſt exſuction you will drive out almoſt a whole cylinder full of air: but at the following exſuctions, you will draw leſs and leſs of air out of the receiver into the cylinder, becauſe there will ſtill remain leſs and leſs air in the receiver itſelf; and conſequently, the particles of the remaining air, having more room to extend themſelves in, will leſs preſs out one another. This you will eaſily perceive, by finding, that you ſtill force leſs and leſs air out of the cylinder; ſo that when the receiver is almoſt exhauſted, you may force up the ſucker almoſt to the top of the cylinder, before you will need to unſtop the valve to let out any air. And if at ſuch time, the valve being ſhut, you let go the handle of the pump, you will find the ſucker forcibly carried up to the top of the cylinder, by the

the protruſion of the external air; which, being much leſs rarified than that within the cylinder, muſt have a more forcible preſſure upon the ſucker, than the internal is able to reſiſt: and by this means you may know how far you have emptied the receiver. And to this we may add, on this occaſion, that conſtantly upon the turning of the key to let out the air from the receiver into the emptied cylinder, there is immediately produced a conſiderably briſk noiſe, eſpecially whilſt there is any plenty of air in the receiver.

FOR the more eaſy underſtanding of the experiments triable by our engine, I thought it not ſuperfluous nor unſeaſonable in the recital of this firſt of them, to inſinuate that notion, by which it ſeems likely, that moſt, if not all of them, will prove explicable. Your Lordſhip will eaſily ſuppoſe, that the notion I ſpeak of is, that there is a ſpring, or elaſtical power in the air we live in. By which ἐλατὴϱ or ſpring of the air, that which I mean is this; that our air either conſiſts of, or at leaſt abounds with, parts of ſuch a nature, that in caſe they be bent or compreſſed by the weight of the incumbent part of the atmoſphere, or by any other body, they do endeavour, as much as in them lieth, to free themſelves from that preſſure, by bearing againſt the contiguous bodies that keep them bent; and, as ſoon as thoſe bodies are removed, or reduced to give them way, by preſently unbending and ſtretching out themſelves, either quite, or ſo far forth as the contiguous bodies that reſiſt them will permit, and thereby expanding the whole parcel of air, theſe elaſtical bodies compoſe.

THIS notion may perhaps be ſomewhat further explained, by conceiving the air near the earth to be ſuch a heap of little bodies, lying one upon another, as may be reſembled to a fleece of wool. For this (to omit other likeneſſes betwixt them) conſiſts of many ſlender and flexible hairs; each of which may indeed, like a little ſpring, be eaſily bent or rolled up; but will alſo, like a ſpring, be ſtill endeavouring to ſtretch it ſelf out again. For though both theſe hairs, and the aëreal corpuſcles to which we liken them, do eaſily yield to external preſſures; yet each of them (by virtue of its ſtructure) is endowed with a power or principle of ſelf-dilatation; by virtue whereof, though the hairs may by a man's hand be bent and crouded cloſer together, and into a narrower room than ſuits beſt with the nature of the body; yet, whilſt the compreſſion laſts, there is in the fleece they compoſe an endeavour outwards, whereby it continually thruſts againſt the hand that oppoſes its expanſion. And upon the removal of the external preſſure, by opening the hand more or leſs, the compreſſed wool doth, as it were, ſpontaneouſly expand or diſplay it ſelf towards the recovery of its former more looſe and free condition, till the fleece hath either regained its former dimenſions, or at leaſt approached them as near as the compreſſing hand (perchance not quite opened) will permit. This power of ſelf-dilatation is ſomewhat more conſpicuous in a dry ſpunge compreſſed, than in a fleece of wool. But yet we rather choſe to employ the latter on this occaſion, becauſe it is not, like a ſpunge, an entire body, but a number of ſlender and flexible bodies, looſely complicated, as the air it ſelf ſeems to be.

THERE is yet another way to explicate the ſpring of the air; namely, by ſuppoſing with that moſt ingenious gentleman, Monſieur *Des Cartes*, that the air is nothing but a congeries or heap of ſmall and (for the moſt part) of flexible particles, of ſeveral ſizes, and of all kind of figures, which are raiſed by heat (eſpecially that of the ſun) into that fluid and ſubtle ethereal body that ſurrounds the earth; and by the reſtleſs agitation of that celeſtial matter, wherein thoſe particles ſwim, are ſo whirled round, that each corpuſcle endeavours to beat off all others from coming within the little ſphere requiſite to its motion about its own centre; and in caſe any, by intruding into that ſphere, ſhall oppoſe its free rotation, to expel or drive it away: ſo that, according to this doctrine, it imports very little, whether the particles of the air have the ſtructure requiſite to ſprings, or be of any other form (how irregular ſoever) ſince their elaſtical power is not made to depend upon their ſhape or ſtructure, but upon the vehement agitation, and (as it were) brandiſhing motion, which they receive from the fluid æther, that ſwiftly flows between them, and whirling about each of them (independently from the reſt) not only keeps thoſe ſlender aëreal bodies ſeparated and ſtretched out (at leaſt, as far as the neighbouring ones will permit) which otherwiſe, by reaſon of their flexibleneſs and weight, would flag or curl; but alſo makes them hit againſt, and knock away each other, and conſequently require more room than that, which, if they were compreſſed, they would take up.

BY theſe two differing ways, my Lord, may the ſprings of the air be explicated. But though the former of them be that, which by reaſon of its ſeeming ſomewhat more eaſy, I ſhall for the moſt part make uſe of in the following diſcourſe; yet am I not willing to declare peremptorily for either of them againſt the other. And indeed, though I have in another treatiſe endeavoured to make it probable, that the returning of elaſtical bodies (if I may ſo call them) forcibly bent, to their former poſition, may be mechanically explicated; yet I muſt confeſs, that to determine whether the motion of reſtitution in bodies proceed from this, that the parts of a body of a peculiar ſtructure are put into motion by the bending of the ſpring, or from the endeavour of ſome ſubtle ambient body, whoſe paſſage may be oppoſed or obſtructed, or elſe its preſſure unequally reſiſted by reaſon of the new ſhape or magnitude, which the bending of a ſpring may give the pores of it: to determine this, I ſay, ſeems to me a matter of more difficulty, than at firſt ſight one would eaſily imagine it. Wherefore I ſhall decline meddling

with

with a ſubject, which is much more hard to be explicated than neceſſary to be ſo by him, whoſe buſineſs it is not, in this letter, to aſſign the adequate cauſe of the ſpring of the air, but only to manifeſt, that the air hath a ſpring, and to relate ſome of its effects.

I KNOW not whether I need annex, that though either of the above-mentioned hypotheſes, and perhaps ſome others, may afford us an account plauſible enough of the air's ſpring; yet I doubt, whether any of them gives us a ſufficient account of its nature. And of this doubt I might here mention ſome reaſons, but that, peradventure, I may (God permitting) have a fitter occaſion to ſay ſomething of it elſewhere. And therefore I ſhould now proceed to the next experiment, but that I think it requiſite, firſt, to ſuggeſt to your Lordſhip what comes into my thoughts, by way of anſwer to a plauſible objection, which I foreſee you may make againſt our propoſed doctrine, touching the ſpring of the air. For it may be alledged, that though the air were granted to conſiſt of ſpringy particles (if I may ſo ſpeak) yet thereby we could only give an account of the dilatation of the air in wind-guns, and other pneumatical engines, wherein the air hath been compreſſed, and its ſprings violently bent by an apparent external force; upon the removal of which, it is no wonder, that the air ſhould, by the motion of reſtitution, expand it ſelf till it hath recovered its more natural dimenſions: whereas in our above-mentioned firſt experiment, and in almoſt all others triable in our engine, it appears not, that any compreſſion of the air preceded its ſpontaneous dilatation or expanſion of it ſelf. To remove this difficulty, I muſt deſire your Lordſhip to take notice, that of whatever nature the air, very remote from the earth, may be, and whatever the ſchools may confidently teach to the contrary, yet we have divers experiments to evince, that the atmoſphere we live in is not (otherwiſe than comparatively to more ponderous bodies) light, but heavy. And did not their gravity hinder them, it appears not why the ſtreams of the terraqueous globe, of which our air in great part conſiſts, ſhould not riſe much higher, than the refractions of the ſun, and other ſtars, give men ground to think, that the atmoſphere, (even in the judgment of thoſe recent aſtronomers, who ſeem willing to enlarge its bounds as much as they dare,) doth reach.

BUT leſt you ſhould expect my ſeconding this reaſon by experience; and leſt you ſhould object, that moſt of the experiments, that have been propoſed to prove the gravity of the air, have been either barely propoſed, or perhaps not accurately tried; I am content, before I paſs further, to mention here, that I found a dry lamb's-bladder containing near about two thirds of a pint, and compreſſed by a packthread tied about it, to loſe a grain and the eighth part of a grain of its former weight, by the receſs of the air upon my having prickt it: And this with a pair of ſcales, which, when the full bladder and the correſpondent weight were in it, would manifeſtly turn either way with the 32^d part of a grain. And if it be further objected, that the air in the bladder was violently compreſſed by the packthread and the ſides of the bladder, we might probably (to wave prolix anſwers) be furniſhed with a reply, by ſetting down the differing weight of our receiver, when emptied, and when full of uncompreſſed air, if we could here procure ſcales fit for ſo nice an experiment; ſince we are informed, that in the German experiment, commended at the beginning of this letter, the ingenious triers of it found, that their glaſs veſſel, of the capacity of 32 meaſures, was lighter when the air had been drawn out of it, than before, by no leſs than one ounce and $\frac{3}{10}$, that is, an ounce and very near a third. But of the gravity of the air, we may elſewhere have occaſion to make further mention.

TAKING it then for granted, that the air is not devoid of weight, it will not be uneaſy to conceive, that that part of the atmoſphere, wherein we live, being the lower part of it, the corpuſcles, that compoſe it, are very much compreſſed by the weight of all thoſe of the like nature, that are directly over them; that is, of all the particles of air, that being piled up upon them, reach to the top of the atmoſphere. And though the height of this atmoſphere, according to the famous *Kepler*, and ſome others, ſcarce exceeds eight common miles; yet other eminent and later Aſtronomers would promote the confines of the atmoſphere to exceed ſix or ſeven times that number of miles. And the diligent and learned *Ricciolo* makes it probable, that the atmoſphere may, at leaſt in divers places, be at leaſt fifty miles high. So that, according to a moderate eſtimate of the thickneſs of the atmoſphere, we may well ſuppoſe, that a column of air, of many miles in height, leaning upon ſome ſpringy corpuſcles of air here below, may have weight enough to bend their little ſprings, and keep them bent: as, (to reſume our former compariſon,) if there were fleeces of wool piled up to a mountainous height upon one another, the hairs, that compoſe the lowermoſt locks, which ſupport the reſt, would, by the weight of all the wool above them, be as well ſtrongly compreſſed, as if a man ſhould ſqueeze them together in his hands, or employ any ſuch other moderate force to compreſs them. So that we need not wonder, that upon the taking off the incumbent air from any parcel of the atmoſphere here below, the corpuſcles, whereof that undermoſt air conſiſts, ſhould diſplay themſelves, and take up more room than before.

AND if it be objected, that in water, the weight of the upper and of the lower part is the ſame; I anſwer, that, (beſides that it may be well doubted whether the obſervation, by reaſon of the great difficulty, hath been exactly made,) there is a manifeſt diſparity betwixt the air and water: for I have not found, upon an experiment purpoſely made, (and in

another treatiſe recorded) that water will ſuffer any conſiderable compreſſion; whereas we may obſerve in wind-guns, (to mention now no other engines) that the air will ſuffer it ſelf to be crouded into a comparatively very little room; in ſo much, that a very diligent examiner of the phænomena of wind-guns would have us believe, that in one of them, by condenſation, he reduced the air into a ſpace at leaſt eight times narrower than it before poſſeſſed. And to this, if we add a noble phænomenon of the experiment *de vacuo*; theſe things put together may for the preſent ſuffice to countenance our doctrine. For that noble experimenter, Monſieur *Paſcal* (the ſon) had the commendable curioſity to cauſe the Torricellian experiment to be tried at the foot, about the middle, and at the top of that high mountain (in *Auvergne*, if I miſtake not) commonly called *Le Puy de Domme*; whereby it was found, that the mercury in the tube fell down lower, about three inches, at the top of the mountain, than at the bottom. And a learned man a while ſince informed me, that a great Virtuoſo, friend to us both, hath, with not unlike ſucceſs, tried the ſame experiment in the lower and upper parts of a mountain in the weſt of *England*. Of which the reaſon ſeems manifeſtly enough to be this, that upon the tops of high mountains, the air, which bears againſt the reſtagnant quickſilver, is leſs preſſed by the leſs ponderous incumbent air; and conſequently is not able totally to hinder the deſcent of ſo tall and heavy a cylinder of quickſilver, as at the bottom of ſuch mountains did but maintain an æquilibrium with the incumbent atmoſphere.

AND if it be yet further objected againſt what hath been propoſed touching the compactneſs and preſſure of the inferiour air, that we find this very air to yield readily to the motion of little flies, and even to that of feathers, and ſuch other light and weak bodies; which ſeems to argue, that the particles of our air are not ſo compreſſed as we have repreſented them, eſpecially ſince, by our former experiment, it appears, that the air readily dilated itſelf downward, from the receiver into the pump, when it is plain, that it is not the incumbent atmoſphere, but only the ſubjacent air in the braſs cylinder that hath been removed: If this, I ſay, be objected, we may reply, that, when a man ſquezeth a fleece of wool in his hand, he may feel, that the wool inceſſantly bears againſt his hand, as that which hinders the hairs it conſiſts of, to recover their former and more natural extent. So each parcel of the air about the earth doth conſtantly endeavour to thruſt away all thoſe contiguous bodies, (whether aëreal or more groſs,) that keep it bent, and hinder the expanſion of its parts, which will dilate themſelves, or fly abroad towards that part, (whether upwards or downwards,) where they find their attempted dilatation of themſelves leſs reſiſted by the neighbouring bodies. Thus the corpuſcles of that air we have been all this while ſpeaking of, being unable, by reaſon of their weight, to aſcend above the convexity of the atmoſphere, and by reaſon of the reſiſtance of the ſurface of the earth and water, to fall down lower, they are forced, by their own gravity and this reſiſtance, to expand and diffuſe themſelves about the terreſtrial globe; whereby it comes to paſs, that they muſt as well preſs the contiguous corpuſcles of air, that on either ſide oppoſe their dilatation, as they muſt preſs upon the ſurface of the earth; and, as it were recoiling thence, endeavour to thruſt away thoſe upper particles of air that lean upon them.

AND, as for the eaſy yielding of the air to the bodies that move in it, if we conſider, that the corpuſcles, whereof it conſiſts, though of a ſpringy nature, are yet ſo very ſmall, as to make up (which it is manifeſt they do) a fluid body, it will not be difficult to conceive, that in the air, as in other bodies that are fluid, the little bodies it conſiſts of, are in an almoſt reſtleſs motion, whereby they become (as we have more fully diſcourſed in another treatiſe) very much diſpoſed to yield to other bodies, or eaſy to be diſplaced by them; and that the ſame corpuſcles are likewiſe ſo variouſly moved, as they are entire corpuſcles, that if ſome ſtrive to puſh a body placed among them towards the right hand (for inſtance) others, whoſe motion hath an oppoſite determination, as ſtrongly thruſt the ſame body towards the left; whereby neither of them proves able to move it out of its place, the preſſure on all hands being reduced as it were to an æquilibrium: ſo that the corpuſcles of the air muſt be as well ſometimes conſidered under the notion of little ſprings, which remaining bent, are in their entire bulk tranſported from place to place; as under the notion of ſprings diſplaying themſelves, whoſe parts fly abroad, whilſt, as to their entire bulk, they ſcarce change place: as the two ends of a bow, ſhot off, fly from one another; whereas the bow it ſelf may be held faſt in the archer's hand. And that it is the equal preſſure of the air on all ſides upon the bodies that are in it, which cauſeth the eaſy ceſſion of its parts, may be argued from hence; that if by the help of our engine the air be but in great part, though not totally, drawn away from one ſide of a body without being drawn away from the other, he that ſhall think to move that body to and fro, as eaſily as before, will find himſelf much miſtaken.

In a diſcourſe touching Fluidity and Firmneſs.

IN verification of which we will, to divert your Lordſhip a little, mention here a phænomenon of our engine, which even to divers ingenious perſons hath at firſt ſight ſeemed very wonderful.

EXPERIMENT II.

THE thing that is wont to be admired, and which may paſs for our ſecond experiment, is this; that if, when the receiver is almoſt empty, a by-ſtander be deſired to lift up the braſs key (formerly deſcribed as a ſtopple in the braſs cover) he will find it a difficult thing

thing to do ſo, if the veſſel be well exhauſted; and even when but a moderate quantity of air hath been drawn out, he will, when he hath lifted it up a little, ſo that it is ſomewhat looſe from the ſides of the lip or ſocket, which (with the help of a little oil) it exactly filled before; he will (I ſay) find it ſo difficult to be lifted up, that he will imagine there is ſome great weight faſtened to the bottom of it. And if (as ſometimes hath been done for merriment) only a bladder be tied to it, it is pleaſant to ſee how men will marvel, that ſo light a body, filled at moſt but with air, ſhould ſo forcibly draw down their hand, as if it were filled with ſome very ponderous thing: whereas the cauſe of this pretty phænomenon ſeems plainly enough to be only this, that the air in the receiver being very much dilated, its ſpring muſt be very much weakned, and conſequently it can but faintly preſs up the lower end of the ſtopple; whereas the ſpring of the external air being no way debilitated, he that a little lifts up the ſtopple, muſt with his hand ſupport a preſſure equal to the diſproportion betwixt the force of the internal expanded air, and that of the atmoſphere incumbent upon the upper part of the ſame key or ſtopple: and ſo men being unuſed to find any reſiſtance, in lifting things up, from the free air above them, they are forward to conclude, that that which depreſſeth their hands muſt needs be ſome weight, though they know not where placed, drawing beneath it.

AND, that we have not miſ-aſſigned the cauſe of this phænomenon, ſeems evident enough by this, that as air is ſuffered by little and little to get into the receiver, the weight, that a man fancieth his hand ſupports, is manifeſtly felt to decreaſe more and more; the internal air by this recruit approaching more to an æquilibrium with the external, till at length the receiver growing again full of air, the ſtopple may be lifted up without any difficulty at all.

BY ſeveral other of the experiments afforded by our engine, the ſame notion of the great and equal preſſure of the free air upon the bodies it environs, might be here manifeſted, but that we think it not ſo fit to anticipate ſuch experiments: and therefore ſhall rather employ a few lines to clear up the difficulty touching this matter, which we have obſerved to have troubled ſome even of the philoſophical and mathematical ſpectators of our engine, who have wondered, that we ſhould talk of the air exquiſitely ſhut up in our receiver, as if it were all one with the preſſure of the atmoſphere; whereas the thick and cloſe body of the glaſs, wholly impervious to the air, doth manifeſtly keep the incumbent pillar of the atmoſphere from preſſing in the leaſt upon the air within the glaſs, which it can no where come to touch. To elucidate a little this matter, let us conſider, that if a man ſhould take a fleece of wool, and having firſt by compreſſing it in his hand reduced it into a narrower compaſs, ſhould nimbly convey and ſhut it cloſe up into a box juſt fit for it; though the force of his hand would then no longer bend thoſe numerous ſpringy bodies that compoſe the fleece, yet they would continue as ſtrongly bent as before, becauſe the box they are incloſed in would as much reſiſt their re-expanding of themſelves, as did the hand that put them in. For thus we may conceive, that the air being ſhut up, when its parts are bent by the whole weight of the incumbent atmoſphere, though that weight can no longer lean upon it, by reaſon it is kept off by the glaſs, yet the corpuſcles of the air within that glaſs continue as forcibly bent, as they were before their incluſion, becauſe the ſides of the glaſs hinder them from diſplaying or ſtretching out themſelves. And if it be objected, that this is unlikely, becauſe even glaſs-bubbles, ſuch as are wont to be blown at the flame of a lamp, exceeding thin, and Hermetically ſealed, will not break; whereas it cannot be imagined, that ſo thin a priſon of glaſs could reſiſt the elaſtical force of all the included air, if that air were ſo compreſſed as we ſuppoſe; it may be eaſily replied, that the preſſure of the inward air againſt the glaſs is countervailed by the equal preſſure of the outward againſt the ſame glaſs. And we ſee in bubbles, that by reaſon of this, an exceeding thin film of water is often able, for a good while, to hinder the eruption of a pretty quantity of air. And this may be alſo more conſpicuous in thoſe great ſpherical bubbles, that boys ſometimes blow with water, to which ſoap hath given a tenacity. But that, if the preſſure of the ambient air were removed, the internal air may be able to break thicker glaſſes, than thoſe lately mentioned, will appear by ſome of the following experiments; to which we ſhall therefore now haſten, having, I fear, been but too prolix in this excurſion, though we thought it not amiſs to annex to our firſt experiments ſome general conſiderations touching the ſpring of the air, becauſe (this doctrine being yet a ſtranger to the ſchools) not only we find not the thing it ſelf to be much taken notice of; but of thoſe few that have heard of it, the greater part have been forward to reject it, upon a miſtaken perſuaſion, that thoſe phænomena are the effects of nature's abhorrency of a vacuum, which ſeem to be more fitly aſcribable to the weight and ſpring of the air.

EXPERIMENT III.

WE will now proceed to obſerve, that though, by the help of the handle, the ſucker be eaſily drawn down to the bottom of the cylinder; yet, without the help of that leaver, there would be required to the ſame effect a force or weight great enough to ſurmount the preſſure of the whole atmoſphere: ſince otherwiſe the air would not be driven out of its place, when none is permitted to ſucceed into the place deſerted by the ſucker. This ſeems evident from the known Torricellian experiment, in which, if the inverted tube of mercury be but 25 digits high,

or

or ſomewhat more, the quickſilver will not fall, but remain ſuſpended in the tube, becauſe it cannot preſs the ſubjacent mercury with ſo great a force, as doth the incumbent cylinder of the air, reaching thence to the top of the atmoſphere: whereas, if the cylinder of mercury were three or four digits longer, it would over-power that of the external air, and run out into the veſſel'd mercury, till the two cylinders came to an æquilibrium, and no further. Hence we need not wonder, that though the ſucker move eaſily enough up and down in the cylinder by the help of the manubrium; yet if the manubrium be taken off, it will require a conſiderable ſtrength to move it either way. Nor will it ſeem ſtrange, that if, when the valve and ſtop-cock are well ſhut, you draw down the ſucker, and then let go the manubrium; the ſucker will, as it were of it ſelf, re-aſcend to the top of the cylinder, ſince the ſpring of the external air findeth nothing to reſiſt its preſſing up the ſucker. And for the ſame reaſon, when the receiver is almoſt evacuated, though, having drawn down the ſucker, you open the way from the receiver to the cylinder, and then intercept that way again by returning the key; the ſucker will, upon the letting go the manubrium, be forcibly carried up almoſt to the top of the cylinder; becauſe the air within the cylinder, being equally dilated and weakened with that of the glaſs, is unable to withſtand the preſſure of the external air, till it be driven into ſo little ſpace, that there is an equilibrium betwixt its force and that of the air without. And congruouſly hereunto we find, that in this caſe the ſucker is drawn down with little leſs difficulty, than if the cylinder, being devoid of air, and the ſtop-cock were exactly ſhut. We might take notice of ſome other things, that depend upon the fabrick of our engine it ſelf; but to ſhun prolixity, we will, in this place, content our ſelves to mention one of them, which ſeems to be of greater moment than the reſt, and it is this; that when the ſucker hath been impelled to the top of the cylinder, and the valve is ſo carefully ſtopped, that there is no air left in the cylinder above the ſucker; if then the ſucker be drawn to the lower part of the cylinder, he that manageth the pump findeth not any ſenſibly greater difficulty to depreſs the ſucker, when it is nearer the bottom of the cylinder, than when it is much farther off. Which circumſtance we therefore think fit to take notice of, becauſe an eminent modern naturaliſt hath taught, that when the air is ſucked out of a body, the violence wherewith it is wont to ruſh into it again, as ſoon as it is allowed to re-enter, proceeds mainly from this; that the preſſure of the ambient air is ſtrengthened upon the acceſſion of the air ſucked out; which, to make it ſelf room, forceth the neighbouring air to a violent ſubingreſſion of its parts: which, if it were true, he that draweth down the ſucker, would find the reſiſtance of the external air increaſed as he draweth it lower, more of the diſplaced air being thruſt into it to compreſs it. But, by what hath been diſcourſed upon the firſt experiment, it ſeems more probable, that without any ſuch ſtrengthening of the preſſure of the outward air, the taking quite away or the debilitating of the reſiſtance from within, may ſuffice to produce the effects under conſideration. But this will perhaps be illuſtrated by ſome or other of our future experiments, and therefore ſhall be no longer inſiſted on here.

EXPERIMENT IV.

HAVING thus taken notice of ſome of the conſtant phænomena of our engine it ſelf, let us now proceed to the experiments triable in it.

WE took then a lamb's bladder large, well dried, and very limber, and leaving in it about half as much air as it could contain, we cauſed the neck of it be ſtrongly tied, ſo that none of the included air, though by preſſure, could get out. This bladder being conveyed into the receiver, and the cover luted on, the pump was ſet on work, and after two or three exſuctions of the ambient air (whereby the ſpring of that which remained in the glaſs was weakened) the impriſoned air began to ſwell in the bladder; and, as more and more of the air in the receiver was, from time to time, drawn out; ſo did that in the bladder more and more expand it ſelf, and diſplay the folds of the formerly flaccid bladder: ſo that before we had exhauſted the receiver near ſo much as we could, the bladder appeared as full and ſtretched, as if it had been blown up with a quill.

AND that it may appear, that this plumpneſs of the bladder proceeded from the ſurmounting of the debilitated ſpring of the ambient air remaining in the veſſel, by the ſtronger ſpring of the air remaining in the bladder; we returned the key of the ſtop-cock, and by degrees allowed the external air to return into the receiver: whereupon it happened, as was expected, that as the air came in from without, the diſtended air in the bladder was proportionably compreſſed into a narrower room, and the ſides of the bladder grew flaccid, till the receiver having re-admitted its wonted quantity of air, the bladder appeared as full of wrinkles and cavities as before.

THIS experiment is much of the ſame nature with that, which was, ſome years ago, ſaid to be made by that eminent geometrician Monſieur *Roberval*, with a carp's bladder emptied and conveyed into a tube, wherein the experiment *de vacuo* was afterwards tried; which ingenious experiment of his juſtly deſerveth the thanks of thoſe, that have been, or ſhall be ſollicitous to diſcover the nature of the air.

BUT to return to our experiment; we may take notice of this circumſtance in it, that after the receiver hath been in ſome meaſure emptied, the bladder doth, at each exſuction, ſwell much more conſpicuouſly than it did

at any of the firſt exſuctions; inſomuch that towards the end of the pumping, not only a great fold or cavity in the ſurface of the bladder may be made even, by the ſtretching of the inward ſelf-expanding air; but we have ſometimes ſeen, upon the turning of the key to let the ambient air paſs out of the receiver into the cylinder, we have ſeen (I ſay) the air in the bladder ſuddenly expand it ſelf ſo much and ſo briſkly, that it manifeſtly lifted up ſome light bodies that leaned upon it, and ſeemed to lift up the bladder itſelf.

Now becauſe it hath, by very learned men, been doubted, whether the ſwelling of the bladder may not have proceeded (not from the dilatation of the included air,) but from the texture of the fibres, which, being wont to keep the bladder extended when the animal (to whom it belonged) was alive, may be ſuppoſed in our experiment to have returned, like ſo many ſprings to their wonted extent, upon the removal of the ambient air that compreſſed and bent them; becauſe this, I ſay, hath been doubted, we thought fit to make this further trial.

WE let down into the receiver with the forementioned bladder two other much ſmaller, and of the ſame kind of animal; the one of theſe was not tied up at the neck, that there might be liberty left to the air that was not ſqueezed out (which might amount to about a fifth part of what the bladder held before) to paſs out into the receiver; the other had the ſides of it ſtretched out and preſſed together, almoſt into the form of a cup, that they might intercept the leſs air betwixt them, and then was ſtrongly tied up at the neck. This done, and the air being in ſome meaſure ſucked out of the pneumatical glaſs (if I may ſo call it) the bladder, mentioned at the beginning of our experiment, appeared extended every way to its full dimenſions; whereas neither of the two others did remarkably ſwell, and that, whoſe neck was not tied, ſeemed very little, if at all leſs wrinkled, than when it was put in.

WE made likewiſe a ſtrong ligature about the middle of a long bladder partly emptied, and, upon the drawing the air out of the receiver, could obſerve no ſuch ſwelling betwixt the ligature and the neck of the bladder, which had been purpoſely left open, as betwixt the ſame ligature and the bottom of the bladder, whence the included air could no way get out.

BUT a farther and ſufficient manifeſtation, whence the intumeſcence of the bladder proceeds, may be deduced from the following experiment.

EXPERIMENT V.

TO try then at once both what it was that expanded the bladder, and what a powerful ſpring there is even in the air we are wont to think uncompreſſed; we cauſed a bladder dry, well tied and blown moderately full, to be hung in the receiver by one end of a ſtring, whoſe other end was faſtened to the inſide of the cover: and upon drawing out the ambient air that preſſed on the bladder; the internal air not finding the wonted reſiſtance, firſt ſwelled and diſtended the bladder, and then broke it, with ſo wide and crooked a rent, as if it had been forcibly torn aſunder with hands. After which a ſecond bladder being conveyed in, the experiment was repeated with like ſucceſs: and I ſuppoſe it will not be imagined, that in this caſe the bladder was broken by its own fibres, rather than by the impriſoned air.

AND of this experiment theſe two phænomena may be taken notice of: the one, that the bladder at its breaking gave a great report, almoſt like a cracker; and the other, that the air contained in the bladder had the power to break it with the mentioned impetuoſity, long before the ambient air was all, or near all, drawn out of the receiver.

BUT, to verify what we ſay in another diſcourſe, where we ſhow, that even true experiments may, by reaſon of the eaſy miſtake of of ſome unheeded circumſtance, be unſucceſsfully tried; we will advertiſe, on this occaſion, that we did oftentimes in vain try the breaking of bladders, after the manner above mentioned; of which the cauſe appeared to be this, that the bladders we could not break, having been brought us already blown from thoſe that ſold them, were grown dry before they came to our hands: whence it came to paſs, that, if we afterwards tied them very hard, they were apt to fret, and ſo become unſerviceable; and if we tied them but moderately hard, their ſtiffneſs kept them from being cloſed ſo exactly, but that when the included air had in the exhauſted receiver diſtended them as much as eaſily it could, it would in part get out between the little wrinkles of the ſphincter of the neck. Whence alſo it uſually happened, that upon the letting in the air from without, the bladders appeared more flaccid and empty than before they were put in; whereas when the bladders were brought us moiſt from the butchers, we could, without injuring them, tie their necks ſo cloſe, that none of the air, once blown in, could get out of them, but by violently breaking them.

IT would not be amiſs on this occaſion to point at ſomething, which may deſerve a more deliberate ſpeculation than we can now afford it; namely, that the elaſtical power of the ſame quantity of air may be as well increaſed by the agitation of the aërial particles (whether only moving them more ſwiftly and ſcattering them, or alſo extending or ſtretching them out, I determine not) within an every way incloſing and yet yielding body; as diſplayed by the withdrawing of the air that preſſed it without. For we found, that a bladder but moderately filled with air and ſtrongly tied, being a while held near the fire, not only grew exceeding turgid and hard, but afterwards, being brought nearer to the fire, ſuddenly broke with ſo loud and vehement a noiſe, as ſtunned thoſe that were by, and made us for a while after almoſt deaf.

EXPERIMENT VI.

HAVING thus ſeen, that the air hath an elaſtical power, we were next deſirous to know in ſome meaſure, how far a parcel of air might by this its own ſpring be dilated. And though we were not provided of inſtruments fit to meaſure the dilatation of the air any thing accurately, yet becauſe an imperfect meaſure of it was more deſirable than none at all, we deviſed the following method as very eaſily practicable.

WE took a limber lamb's bladder, which was thoroughly wetted in fair water, that the ſides of it being ſqueezed together, there might be no air left in its folds; (as indeed we could not afterwards upon trial diſcern any.) The neck of this bladder was ſtrongly tied about that of a ſmall glaſs, (capable of holding five full drachms of water) the bladder being firſt ſo compreſſed, that all the included air was only in the glaſs, without being preſſed there. Then the pump being ſet on work, after a few exſuctions, the air in the little phial began to dilate itſelf, and produce a ſmall tumour in the neck of the bladder; and as the ambient air was more and more drawn away, ſo the included air penetrated farther and farther into the bladder, and by degrees lifted up the ſides and diſplayed its folds, till at length it ſeemed to have blown it up to its full extent: whereupon the external air, being permitted to flow back into the receiver, repulſed the air that had filled the bladder into its former narrow receptacle, and brought the bladder to be again flaccid and wrinkled as before. Then taking out the bladder, but without ſevering it from the glaſs, we did, by a hole made at the top of the bladder, fill the veſſel, they both made up, with water, whoſe weight was five ounces five drachms and a half: five drachms whereof were above mentioned to be the contents of the bottle. So that in this experiment, when the air had moſt extended the bladder, it poſſeſſed in all above nine times as much room as it did when it was put into the receiver. And it would probably have much enlarged its bounds, but that the bladder by its weight, and the ſticking together of its ſides, did ſomewhat reſiſt its expanſion: and, which was more conſiderable, the bladder appeared tumid enough, whilſt yet a pretty deal of air was left in the receiver, whoſe exſuction would, according to our former obſervation, probably have given way to a farther expanſion of the air, eſpecially ſuppoſing the dilatation not to be reſtrained by the bladder.

SINCE we wrote the other day the former experiment, we have met with ſome glaſſes not very unfit for our purpoſe; by means of which we are now able, with a little more trouble, to meaſure the expanſion of the air a great deal more accurately than we could by the help of the above-mentioned bladder, which was much too narrow to allow the air its utmoſt diſtenſion.

WE took then firſt a cylindrical pipe of glaſs, whoſe bore was about a quarter of an inch in diameter: this pipe was ſo bent and doubled, that, notwithſtanding its being about two foot in length, it might have been ſhut up into a ſmaller receiver, not a foot high; but by misfortune it cracked in the cooling, whereby we were reduced to make uſe of one part which was ſtraight and entire, but exceeded not ſix or ſeven inches. This little tube was open at one end; and at the other, where it was hermetically ſealed, had a ſmall glaſs bubble to receive the air whoſe dilatation was to be meaſured.

ALONG the ſide of this tube was paſted a ſtraight narrow piece of parchment, divided into twenty-ſix equal parts, marked with black lines and figures, that by them might be meaſured both the included air and its dilatation. Afterwards we filled the tube with water almoſt to the top; and ſtopping the open end with the finger, and inverting the tube, the air was permitted to aſcend to the above mentioned glaſs bubble. And by reaſon this aſcent was very ſlow, it gave us the opportunity to mark how much more or leſs than one of the twenty-ſix diviſions this air took up. By this means, after a trial or two, we were enabled to convey to the top of the glaſs a bubble of air equal enough, as to ſight, to one of thoſe diviſions. Then the open end of the tube being put into a ſmall phial, whoſe bottom was covered with water, about half an inch high; we included both glaſſes into a ſmall and ſlender receiver, and cauſed the pump to be ſet on work. The event was, that at the firſt exſuction of the air there appeared not any expanſion of the bubble, comparable to what appeared at the ſecond, and that upon a very few exſuctions the bubble reaching as low as the ſurface of the ſubjacent water, gave us cauſe to think, that if our pipe had not been broken, it would have expanded itſelf much farther: wherefore we took out the little tube, and found, that beſides the twenty-ſix diviſions formerly mentioned, the glaſs bubble and ſome part of the pipe, to which the divided parchment did not reach, amounted to ſix diviſions more. Whereby it appears, that the air hath taken up one and thirty times as much room as before, and yet ſeem'd capable of a much greater expanſion, if the glaſs would have permitted it. Wherefore after the former manner, we let in another bubble, that by our gueſs was but half as big as the former, and found, that upon the exſuction of the air from the receiver, this little bubble did not only fill up the whole tube, but (in part) break through the ſubjacent water in the phial, and thereby manifeſt itſelf to have poſſeſſed ſixty and odd times its former room.

THESE two experiments are mentioned to make way for the more eaſy belief of that which is now to follow. Finding then that our tube was too ſhort to ſerve our turn, we took a ſlender quill of glaſs, which happened to be at hand, though it were not ſo fit for

our

our purpoſe as we could have wiſhed, in regard it was three or four times as big at one end as the other. This pipe, which was thirty inches long, being hermetically ſealed at the ſlender end, was almoſt filled with water; and after the above related manner a bubble was conveyed to the top of it, and the open extreme was put into a phial that had a little fair water at the bottom: then the cover, by means of a ſmall hole purpoſely made in it for the glaſs pipe to ſtand out at, was cemented on to the receiver, and the pump being ſet on work, after ſome exſuctions, not only the air manifeſtly appeared extended below the ſurface of the ſubjacent water, but one of the by-ſtanders affirms, that he ſaw ſome bubbles come out at the bottom of the pipe, and break through the water. This done, we left off pumping, and obſerved how at the unperceived leaks of the receiver the air got in ſo faſt, that it very quickly impelled up the water to the top of the tube, excepting a little ſpace whereinto that bubble was repulſed, which had ſo lately poſſeſſed the whole tube. This air at the ſlender end appeared to be a cylinder of $\frac{5}{6}$ parts of an inch in length, but when the pipe was taken out and turned upſide down, it appeared at the other end inferior in bulk to a pea.

THESE things being thus done, we took (to make the experiment the more exactly) a ſmall pair of ſcales, ſuch as goldſmiths uſe to weigh gold coin in; and weighing the tube and water in it, we found them to amount to one ounce thirty grains and an half: then we poured in as much water as ſerved to fill up the tube, wherein before we had left as much ſpace unfilled up as was poſſeſſed by the bubble; and weighing again the pipe and water, we found the weight increaſed only by one grain. Laſtly, pouring out the water, and carefully freeing the pipe from it, (which yet we could not perfectly do) we weighed the glaſs alone, and found it to want two drachms and thirty-two grains of its former weight: ſo that the bubble of air taking up the room but of one grain in weight of water, it appeared, that the air by its own ἐλατήϱ was ſo rarified, as to take up one hundred fifty-two times as much room as it did before; though it were then compreſſed by nothing but the ordinary preſſure of the contiguous air. I know not whether it be requiſite to take notice, that this experiment was made indeed in a moiſt night, but in a room, in whoſe chimney there was burning a good fire, which did perhaps ſomewhat rarify the air, of which the bubble conſiſted.

IT hath ſeemed almoſt incredible, which is related by the induſtrious *Merſennus*, that the air, by the violence of heat, though as great as our veſſels can ſupport without fuſion, can be ſo dilated as to take up ſeventy times as much room as before: wherefore becauſe we were willing to have a confirmation of ſo ſtrange a phænomenon, we once more conveyed into the tube a bubble of the bigneſs of the former, and proſecuting the experiment as before with the ſame water, we obſerved, that the air did manifeſtly ſtretch itſelf ſo far, as to appear ſeveral times a good way below the ſurface of the water in the phial, and that too with a ſurface very convex toward the bottom of the pipe. Nay, the pump being plied a little longer, the air did manifeſtly reach to that place, where the bottom of the tube leaned upon the bottom of the phial, and ſeemed to knock upon it and rebound from it: which circumſtances we add, partly that the phænomenon we have been relating may not be imputed to the bare ſubſiding of the water that filled the tube, upon the taking off the preſſure of ambient air; and partly alſo, that it may appear, that if our experiments have not been ſo accurately made as with fitter inſtruments might perhaps be poſſible, yet the expanſion of the air is likely to be rather greater than leſſer than we have made it; ſince the air was able to preſs away the water at the bottom of the pipe, though that were about two inches below the ſurface of the water that was then in the phial, and would have been at leaſt as high in the pipe, if the water had only ſubſided and not been depreſſed: ſo that it ſeems not unlikely, that if the experiment could be ſo made, as that the expanſion of the air might not be reſiſted by the neighbouring bodies, it would yet enlarge its bounds, and perhaps ſtretch itſelf to two hundred times its former bulk, if not more. However, what we have now tried will, I hope, ſuffice to hinder divers of the phænomena of our engine from being diſtruſted: ſince in that part of the atmoſphere we live in, that which we call the free air (and preſume to be ſo uncompreſſed) is crouded into ſo very ſmall a part of that ſpace, which, if it were not hindered, it would poſſeſs. We would gladly have tryed alſo, whether the air at its greateſt expanſion could be farther rarified by heat; but, do what we could, our receiver leaked too faſt to let us give our ſelves any ſatisfaction in that particular.

EXPERIMENT VII.

TO diſcover likewiſe, by the means of that preſſure of the air, both the ſtrength of glaſs, and how much intereſt the figure of a body may have in its greater or leſſer reſiſtance to the preſſure of other bodies, we made theſe farther trials.

WE cauſed to be blown with a lamp a round glaſs bubble, capable of containing, by gueſs, about five ounces of water, with a ſlender neck about the bigneſs of a ſwan's quill; and it was purpoſely blown very thin, as phials made with lamps are wont to be, that the thinneſs of the matter might keep the roundneſs of the figure from making the veſſel too ſtrong. Then having moderately emptied the receiver, and taken it out of the pump, we ſpeedily applied to the orifice of the bottom of it, the neck of the newly mentioned glaſs, carefully ſtopping the crannies with melted plaiſter, that no air might get in

at

at them: and after turning the key of the ſtop-cock, we made a free paſſage for the air to paſs out of the bubble into the receiver; which it did with great celerity, leaving the bubble as empty as the receiver itſelf, as appeared to us by ſome circumſtances not now to be inſiſted on. Notwithſtanding all which, the veſſel, continuing as intire as before, gave us cauſe to wonder that the bare roundneſs of the figure ſhould enable a glaſs, almoſt as thin as paper, to reſiſt ſo great a preſſure as that of the whole incumbent atmoſphere. And having reiterated the experiment, we found again, that the preſſure of the ambient body, thruſting all the parts inwards, made them, by reaſon of their arched figure, ſo ſupport one another, that the glaſs remained as whole as at firſt.

Now that the figure of the glaſs is of great moment in this matter, may be evinced by this other experiment.

EXPERIMENT VIII.

WE took a glaſs helmet or alembick (delineated by the ſeventh figure) ſuch as chymiſts uſe in diſtillations, and containing by conjecture between two and three pints: the roſtrum or roſe of it marked with *c* was hermetically cloſed; and at the top of it was a hole, into which was fitted and cemented one of the ſhanks of a middle-ſized ſtop-cock; ſo that the glaſs being turned upſide-down, the wide orifice (which in common glaſs-helmets is the only one) was upwards; and to that wide orifice was fitted a caſt cover of lead, which was carefully cemented on to the glaſs: then the other ſhank of the ſtop-cock being with cement likewiſe faſtened into the upper part of the pump, the exſuction of the air was endeavoured. But it was not long before, the remaining air being made much too weak to balance the preſſure of the ambient air, the glaſs was (not without a great noiſe) cracked almoſt half round, along that part of it where it began to bend inwards; as if in the figure the crack had been made according to the Line *a b*. And upon an endeavour to pump out more of the air, the crack once begun, appeared to run on farther; though the glaſs where it was broken ſeemed to be (by conjecture) above ten, ſome thought above twenty times, as thick as the bubble mentioned in the foregoing experiment.

THIS will perhaps make it ſeem ſtrange, that having taken another glaſs bubble blown at the ſame time, and like, for aught we diſcerned for ſize, thickneſs, and figure, to that thin one formerly mentioned; and having ſealed it up hermetically, and ſuſpended it in the receiver, the exſuction of the ambient air did not enable the impriſoned air to break, or in the leaſt to crack the bubble; though the experiment were laboriouſly tried, and that ſeveral times with bubbles of other ſizes: but that perhaps the heat of the candle or lamp wherewith ſuch glaſſes are hermetically ſealed, (not to mention the warmth of his hands that ſealed it) might ſo rarify the contained air, as much to weaken its ſpring, may ſeem probable by the following experiments.

EXPERIMENT IX.

WE took a glaſs phial able to hold three or four ounces of water, and of the thickneſs uſual in glaſſes of that ſize; into the neck of this was put a moderately ſlender pipe of glaſs, which was carefully faſtened, with a mixture of equal parts of pitch and reſin, to the neck of the phial, and which reached almoſt to the bottom of it, as the ſixth figure declareth.

THIS phial being, upon a particular deſign, filled with water, till that came up in it, a pretty deal higher than the lower end of the pipe, was put into one of our ſmall receivers, (containing between a pint and a quart) in ſuch manner as that the glaſs pipe, paſſing through a hole made purpoſely for it in the leaden cover of the receiver, was for the moſt part of it without the veſſel, which being exactly cloſed, the pump was ſet on work: but at the very firſt exſuction, and before the ſucker was drawn to the bottom of the cylinder, there flew out of the phial a piece of glaſs half as broad as the palm of a man's hand, and it was thrown out with ſuch violence, that hitting againſt the neighbouring ſide of the receiver, it not only daſhed itſelf to pieces, but cracked the very receiver in many places, with a great noiſe that much ſurpriſed all that were in the room. But it ſeemed, that in ſo little a receiver, the air about the phial being ſuddenly drawn out, the air impriſoned in the veſſel, having on it the whole preſſure of the atmoſphere (to which by the pipe open at both ends, it and the water were expoſed) and not having on the other ſide the wonted preſſure of the ambient air to balance that other preſſure, the reſiſtance of glaſs was finally ſurmounted, and the phial once beginning to break where it was weakeſt, the external air might ruſh in with violence enough to throw the cracked parcel ſo forcibly againſt the neighbouring ſide of the receiver, as to break that too.

AND this may be preſumed ſufficient to verify what we delivered in that part of our appendix to the firſt experiment, where we mentioned the almoſt equal preſſure of the air on either ſide of a thin glaſs veſſel, as the cauſe of its not being broken by the forcible ſpring of the contained air. But yet that it be not ſuſpected, that chance had an intereſt in ſo odd an experiment as we have been relating, we will add, that, for farther ſatisfaction, we reiterated it in a round glaſs containing by gueſs about ſix ounces of water: this phial we put into ſuch a ſmall receiver as was lately mentioned, in ſuch manner, as that the bottom of it reſted upon the lower part of the pneumatical glaſs, and the neck came out through the leaden cover of the ſame at a hole made purpoſely for it. But being made

circumſpect by the foregoing miſchance, we had put the phial into a bladder, before we put it into the receiver to hinder this laſt-named glaſs from being endangered by the breaking of the other. Then the pneumatical veſſel being cloſed, ſo that no way was left for the outward air to get into it, but by breaking through the phial, into whoſe cavity it had free acceſs by the mouth of it, (which was purpoſely left open,) the ſucker being nimbly drawn down, the external air immediately preſſed forcibly as well upon the leaden-cover as the phial; and the cover happening to be in one place a little narrower than the edge of the pneumatical glaſs, was depreſſed, and thruſt into it ſo violently by the incumbent air, that getting a little within the tapering lip of the glaſs, it did (like a kind of wedge) thruſt out that ſide where it was depreſſed, ſo as, (though the receiver was new) to ſplit it. This accident being thus mentioned upon the bye to confirm what we formerly ſaid touching the fitneſs or unfitneſs of glaſſes of ſome figures to reſiſt the preſſure of the atmoſphere; we will proceed to relate the remaining part of the experiment: namely, that having fitted on a wider cover to the ſame receiver, and cloſed both that and the crack with cement, we proſecuted the experiment in the manner above related, with this ſucceſs; that upon the quick depreſſing of the ſucker, the external air burſt the body of the phial into above an hundred pieces, many of them exceeding ſmall, and that with ſuch violence, that we found a wide rent, beſides many holes, made in the bladder it ſelf.

AND to evince, that theſe phænomena were the effects of a limited and even moderate force, and not of ſuch an abhorrency of a vacuum, as that to avoid it, many have been pleaſed to think, that nature muſt, upon occaſion, exerciſe an almoſt boundleſs power; we afterwards purpoſely tried this experiment with ſeveral glaſſes ſomewhat thicker than thoſe phials, and found the event to verify our conjecture, that it would not ſucceed: for the glaſſes were taken out as intire as they were put in.

AND here, my Lord, I hold it not unfit, upon occaſion of the mention that hath been made of our having employed ſmall receivers, and one of them, notwithſtanding its being cracked, to annex theſe two advertiſements.

FIRST then, beſides the great pneumatical glaſs ſo often mentioned, and the proportionate ſtop-cock, we thought fit to provide our ſelves with ſome ſmall receivers, blown of cryſtalline glaſs, of ſeveral ſhapes, and furniſhed with ſmaller ſtop-cocks purpoſely made; and this we did upon hopes, that when we had ſurmounted the difficulties to be met with in cementing the glaſſes to the ſtop-cocks, and the pneumatical veſſels to the pump, ſo exquiſitely as is requiſite for our purpoſe, we ſhould from the ſmallneſs of our receivers receive a four-fold advantage. The firſt, that by reaſon of the ſlenderneſs of the veſſels, and their being made of much purer and clearer metal (as the glaſs-men ſpeak) than the great receiver, we might have a more perfect view of every thing happening within them. The next, that ſuch ſmall veſſels might be emptied with leſs labour and in much leſs time. The third, that this nimble exſuction of the ambient air would make many changes in the bodies ſhut up in theſe glaſſes more ſudden and conſpicuous, than otherwiſe they would prove. And the laſt, that we ſhould be able to draw and keep out the air much more perfectly from ſuch ſmall veſſels than from our large receiver: but though we were not much diſappointed in the expectation of the three firſt advantages, yet we were in our hopes of the fourth; for beſides the great difficulty we found in fitting together the glaſſes, the ſtop-cocks, and the covers; beſides this, I ſay, we found our ſelves ſeldom able to draw, and keep out the air ſo far as to make the remaining air in theſe receivers weaker than the remaining air in our great receiver. For though ſometimes the leaks of ſome of theſe little receivers may be much (either fewer or ſmaller) than thoſe of the larger veſſel; yet a little air getting into one of theſe, wherein it had but little room to expand and diſplay it ſelf, might preſs as much upon all parts of the internal ſurface of the veſſel, and upon the included bodies, as a greater quantity of the air in a veſſel in whoſe capacity it might find more room to expand itſelf.

THE other thing, that we were to advertiſe, is, that, it is not every ſmall crack that can make ſuch a receiver as is of a roundiſh figure altogether uſeleſs to our experiment, in regard that upon the exſuction of the internal air, the ambient air on all ſides preſſing the glaſs inwards or towards the middle, doth conſequently thruſt the lips of the crack cloſer, and ſo rather cloſe than increaſe it.

THIS I mention partly becauſe receivers fit for our turn are more eaſily cracked than procured, and therefore ought not to be unneceſſarily thrown away as unſerviceable; and partly, becauſe I think it becomes one, that profeſſeth himſelf a faithful relator of experiments not to conceal from your Lordſhip, that after a few of the foregoing experiments were made, there happened in the great receiver a crack of about a ſpan long, beginning at the upper orifice, and occaſioned, as it ſeemed, by the exceſſive heat of too large an iron that was employed to melt the cement about that orifice. But having laid upon this crack a broad plaiſter, (which in one of our eſſays, written ſome years ſince, to your ingenious and hopeful couſin *Jones*, we extol for the mending of cracked receivers, and other chymical glaſſes;) and having afterwards thickly overlaid this plaiſter with diachylon, we neither could then, nor can yet perceive, that the veſſel leaks ſenſibly at that crack.

THE plaiſter was made of good quick lime finely poudered, and nimbly ground with a peſtle in a mortar, with a quantity (I know not how much preciſely, not having thoſe eſſays in this place) of ſcrapings of cheeſe

and a little fair water, no more than is juſt neceſſary to bring the mixture to a ſomewhat ſoft paſte, which, when the ingredients are exquiſitely incorporated, will have a ſtrong and ſtinking ſmell: then it muſt be immediately ſpread upon a linen cloth of three or four fingers breadth, and preſently applied, leſt it begin to harden. But if your Lordſhip had ſeen, how we mended with it receivers even for the moſt ſubtle chymical ſpirits, you would ſcarce wonder at the ſervice it hath done in our pneumatical glaſs.

EXPERIMENT X.

WE took a tallow-candle of ſuch a ſize, that eight of them make about a pound; and having in a very commodious candleſtick let it down into the receiver, and ſo ſuſpended it, that the flame burnt almoſt in the middle of the veſſel, we did in ſome two minutes exactly cloſe it up: and upon pumping very nimbly, we found, that, within little more than half a minute after, the flame went out, though the ſnuff had been purpoſely left of that length we judged the moſt convenient for the laſting of the flame.

BUT the ſecond time having put in the ſame candle into the receiver, (after it had by the blaſts of a pair of bellows been freed from fumes) the flame laſted about two minutes from the time the pumper began to draw out the air; upon the firſt exſuction whereof, the flame ſeemed to contract it ſelf in all its dimenſions. And theſe things were farther obſervable, that after the two or three firſt exſuctions of the air, the flame (except at the very top) appeared exceeding blue, and that the flame ſtill receded more and more from the tallow, till at length it appeared to poſſeſs only the very top of the wiek, and there it went out.

THE ſame candle being lighted again was ſhut into the receiver, to try how it would laſt there without drawing forth the air, and we found, that it laſted much longer than formerly; and before it went out, receded from the tallow towards the top of the wiek, but not near ſo much as in the former experiment.

AND having an intention to obſerve particularly, what the motion of the ſmoke would be in theſe experiments, we took notice, that when the air was not drawn out, there did, upon the extinction of the flame, a conſiderable part of the wiek remain kindled, which (probably by reaſon of the circulation of the air in the veſſel, occaſioned by the heat) emitted a ſteam, which aſcended ſwiftly and directly upwards in a ſlender and uninterrupted cylinder of ſmoke, till it came to the top, whence it manifeſtly recoiled by the ſides to the lower part of the veſſel. Whereas when the flame went out upon the exſuction of the air one time (when the flame retired very leiſurely to the top) we perceived it not to be followed by any ſmoke at all. And at another time the upper part of the wiek remaining kindled after the extinction of the flame, the ſlender ſteam of fumes that did ariſe aſcended but a very little way, and then after ſome uncertain motions this and that way, did, for the moſt part, ſoon fall downwards.

BEING deſirous alſo to try, whether there would be any difference as well in our receiver, as there is wont to be elſewhere betwixt candles made of wax and thoſe made of tallow, as to their duration; we took ſlender tapers of white wax, (commonly called virgins wax) that being found to burn with much leſs ſmoke than common yellow wax. Six of theſe of like bigneſs, and each of them of about the thickneſs of a ſwan's quill, we preſſed together into one candle: and having lighted all the wieks, we let in the abovementioned wax-candle into the receiver, and made what haſte we could to cloſe it up with cement. But, though in the mean while we left open the valve of the cylinder, the hole of the ſtop-cock, and that in the cover of the receiver, that ſome air might get in to cheriſh the flame, and the ſmoke might have a vent; yet for ſo great a flame the air ſufficed not ſo much as till the cover could be perfectly luted on: ſo that before we were quite ready to imploy the pump, the candle was extinguiſhed. Wherefore we took but one of the abovementioned tapers, and having lighted it, cloſed it up in the receiver, to try how long a ſmall flame with a proportionable ſmoke would continue in ſuch a quantity of air: but we found upon two ſeveral trials, that from the beginning of pumping, the flame went out in about a minute of an hour. It appeared indeed to us, that the ſwinging of the wire to and fro (in the engine ſhaken by pumping) haſtened the vaniſhing of the flame, which ſeemed by that motion to be caſt ſometimes on one ſide of the wiek and ſometimes on the other. But though once we purpoſely refrained pumping after a very few exſuctions of the air, that the flame might not be agitated, yet it laſted not much longer than the newly-mentioned time. And laſtly, cloſing up the ſame taper, lighted again, to diſcover how long it would laſt without drawing out of the air, we found that it burnt for a while vividly enough, but afterwards began to be leſſened more and more in all its dimenſions. And we obſerved, that the flame did not, as before, retire it ſelf by little and little towards the top, but towards the bottom of the wiek (from which yet it did a little withdraw upwards juſt before it went out) ſo that the upper part of the wiek appeared for a pretty while manifeſtly above the top of the flame, which having laſted about five minutes, was ſucceeded by a directly aſcending ſtream of ſmoke.

EXPERIMENT XI.

THERE was taken a wire, which being bent almoſt in the form of a ſcrew, conſtituted ſuch an inſtrument, to contain coals, and leave them every way acceſſible to the

the air, as the tenth figure declareth; the breadth of this veſſel was no leſs than that it might with eaſe be convey'd into the receiver: and having filled it to the height of about five inches with throughly kindled wood-coals, we let it down into the glaſs; and ſpeedily cloſing it, we cauſed the pumper to ply his work, and obſerved, that upon the very firſt exſuction of the air (though perhaps not becauſe of that only) the fire in the coals began to grow very dim, and though the agitation of the veſſel did make them ſwing up and down (which in the free air would have retarded the extinction of the fire) yet when we could no longer diſcern any redneſs at all in any of them, caſting our eyes upon a minute watch we kept by us on this occaſion, we found, that from the beginning of the pumping (which might be about two minutes after the coals had been put in glowing) to the total diſappearing of the fire, there had paſſed but three minutes.

WHEREUPON, to try the experiment a little farther, we preſently took out the coals, in which it ſeems there had remained ſome little parcels of fire, rather covered than totally quenched: for in the open air the coals began to be re-kindled in ſeveral places, wherefore having by ſwinging them about in the wire, throughly lighted them the ſecond time, we let them down again into the receiver, and cloſed it ſpeedily as before; and then waiting till the fire ſeemed totally extinct, without meddling with the pump, we found that from the time the veſſel was cloſed, till that no fire at all could be perceived, there had paſſed about four minutes: whereby it ſeemed to appear, that the drawing away of the ambient air made the fire go out ſooner than otherwiſe it would have done; though that part of the air that we drew out, left the more room for the ſtifling ſteams of the coals to be received into.

LASTLY, having taken out the wire and put other coals into it, we did, in the ſame room where the engine ſtood, let it hang quietly by a ſtring in the open air, to try how long the fire would laſt without agitation, when no air was kept from it; and we found, that the fire began to go out firſt at the top and outſides of the coals, but inwards and near the bottom the fire continued viſible for above half an hour; a great part of the coals, eſpecially thoſe next the bottom, being burnt to aſhes before the fire went out.

WE cauſed likewiſe a piece of iron to be forged, of the bigneſs of a middle-ſized char-coal, and having made it red-hot throughout; we cauſed it in the lately mentioned wier, to be ſpeedily conveyed and ſhut up into the receiver, being deſirous to try what would become of a glowing body, by reaſon of its texture more vehemently hot than a burning coal of the ſame bigneſs, and yet unlike to ſend forth ſuch copious and ſtifling fumes: but we could not obſerve any manifeſt change upon the exſuction of the air. The iron began indeed to loſe its firy redneſs at the top, but that ſeemed to be becauſe it was at the upper end ſomewhat more ſlender than at the lower: the redneſs, though it were in the daytime, continued viſible about four minutes; and then, before it did quite diſappear, we turned the key of the ſtop-cock, but could not diſcern any change of the iron upon the ruſhing in of the air. Yet ſome little remainders of wax that ſtuck to the wire, and were turned into fumes by the heat of the neighbouring iron, ſeemed to afford a more plentiful, or at leaſt a much more expanded ſmoke, when the air was ſucked out, than afterwards, though allowance was made for the decreaſing heat of the iron. And laſtly, notwithſtanding a conſiderable exſuction of the ambient air, though not by far ſo great a one as might have been made by the engine; and notwithſtanding the inconſiderable diſſipation of the parts of the iron; the ſurrounding ſides of the receiver were ſenſibly, and almoſt offenſively heated by it; inſomuch that a pretty while after the iron was taken out, the ſides of the glaſs manifeſtly retained a warmth: which would not be unfit to be conſidered by a perſon at more leiſure than I am now.

EXPERIMENT XII.

BEING willing to try after this ſomething, that would not cheriſh much fire at once, and would keep fire much longer than a coal; we took a piece of match, ſuch as ſoldiers uſe, of the thickneſs of a man's little finger, or ſomewhat thicker; and this being well lighted at one end, was by a ſtring ſuſpended with that end downwards in the cavity of the receiver, which was immediately cloſed: and yet by that time it could well be ſo, the copious fumes of the match had near filled and darkened the receiver. Wherefore, leſt the veſſel ſhould be endangered, the pump was nimbly plied, and a great deal of air and ſmoke mixt together was drawn out, whereby the receiver growing more clear, we could diſcern the fire in the match to burn more and more languidly: and notwithſtanding that by the diligence uſed in pumping, it ſeemed to have room enough allowed it to throw out fumes; yet, after no long time, it ceaſed from being diſcernable either by its light or its ſmoke. And, though by that we were invited to ſuppoſe it quite extinguiſhed, yet we continued pumping a-while, in proſecution of another experiment we were trying at the ſame time: and this we did the more willingly, becauſe of a ſuſpicion the experiment about the coals might eaſily ſuggeſt, and which the event declared not to have been altogether groundleſs. For upon the admiſſion of the external air, the fire, that ſeemed to have gone out a pretty while before, did preſently revive; and being as it were refreſhed by the new air, and blown by the wind made by that air in ruſhing in, it began again to ſhine and diſſipate the neighbouring fuel into ſmoke as formerly.

EX-

EXPERIMENT XIII.

AWHILE after we let down into the receiver, together with a lighted piece of match, a great bladder well tied at the neck, but very lank, as not containing actually much (if any thing) above a pint of air, but being capable of containing ten or twelve times as much.

OUR ſcope in this experiment was partly to try, whether or no the ſmoke of the match, repleniſhing the receiver, would be able to hinder the dilatation of the inward air, upon the exſuction of the ambient; and partly to diſcover, whether the extinction of the fire in the match did proceed from want of air, or barely from the preſſure of its own fumes, which, for want of room to expand themſelves in, might be ſuppoſed to recoil upon the fire, and ſo to ſtifle it.

THE event of our trial was, that at the beginning of our pumping the match appeared well lighted, though it had almoſt filled the receiver with its plentiful fumes: but by degrees it burnt more and more dimly, notwithſtanding, that by the nimble drawing out the air and ſmoke, the veſſel were made leſs opacous, and leſs full of compreſſing matter; as appeared by this, that the longer we pumped, the leſs air and ſmoke came out of the cylinder at the opening of the valve, and conſequently the leſs came into it before; yet the fire in the match went but ſlowly out. And when afterwards, to ſatisfy our ſelves of its expiration, we had darkened the room, and in vain endeavoured to diſcover any ſpark of fire, (as we could not for ſome time before by the help of candles diſcern the leaſt riſing of ſmoke,) we yet continued pumping ſix or ſeven times; and after all that, letting in the air, the ſeemingly dead fire quickly revived, and manifeſted its recovery by light and ſtore of ſmoke, with the latter of which it quickly began to repleniſh the receiver. Then we fell to pumping afreſh, and continued that labour ſo long, till the re-kindled match went out again: and thinking it then fit not to ceaſe from pumping ſo ſoon as before, we found, that in leſs than half a quarter of an hour the fire was got out for good and all, and paſt the poſſibility of being recovered by the re-admitted air.

SOME circumſtances beſides thoſe already mentioned, occurred in the making of the experiment; of which theſe are the principal.

FIRST, when the receiver was full of ſmoke, if the cylinder were emptied, immediately upon the turning of the ſtop-cock, the receiver would appear manifeſtly darkened to his eye that looked upon the light through it; and this darkneſs was much leſs when the receiver was much leſs filled with fumes: it was alſo inſtantaneous, and ſeemed to proceed from a ſudden change of place and ſituation in the exhalations, upon the vent ſuddenly afforded them and the air they were mixt with, out of the receiver into the cylinder.

THE next thing we obſerved was a kind of halos that appeared a good while about the fire, and ſeemed to be produced by the ſurrounding exhalations.

AND laſtly, it is remarkable, that even when the fumes ſeemed moſt to repleniſh the receiver, they did not ſenſibly hinder the air included in the bladder from dilating it ſelf after the ſame manner (for aught we could diſcern) as it would have otherwiſe done: ſo that before the fire or the match was quite extinct, the bladder appeared ſwelled at leaſt to ſix or ſeven times its former capacity.

SINCE the writing of theſe laſt lines, we took a ſmall receiver, capable of containing (by gueſs) about a pound and a half of water; and in the midſt of it we ſuſpended a lighted match; but though within one minute of an hour (or thereabouts) from the putting in of the match, we had cemented on the cover, yet we could not make ſuch haſte, but that before we began to pump, the ſmoke had ſo filled that ſmall receiver, as for aught we diſcerned, to choke the fire. And having again and again reiterated the experiment, it ſeemed ſtill as at firſt, that we could not cloſe up the veſſel, and pump out all the fumes time enough to reſcue the fire from extinction, whereupon we made uſe of this expedient. As ſoon as we had pumped once or twice, we ſuddenly turned the key, and thereby gave acceſs to the excluded air, which ruſhing violently in, as if it had been forced thorow a pair of bellows, did both drive away the aſhes, fill the glaſs with freſh air, and by blowing the almoſt extinguiſhed fire, re-kindled it, as appeared by the match's beginning again to ſmoke, which before it had ceaſed to do. We having by this means obtained a lighted match in the receiver, without being reduced to ſpend time to cloſe it up, commanded the air to be immediately pumped out, and found, that upon the exſuction of it, the match quickly left ſmoking, as it ſeemed, by reaſon of the abſence of the air; and yet if ſome urgent occaſions had not hindered us, we would for greater ſecurity have tried, whether or no the match re-kindled as formerly, would ſmoke much longer, in caſe of no exſuction of the ambient air.

EXPERIMENT XIV.

TO try divers things at once, and particularly whether fire, though we found it would not long laſt, might not be produced in our evacuated receiver; we took a piſtol of about a foot in length, and having firmly tied it to a ſtick almoſt as long as the cavity of the receiver, we very carefully primed it with well-dried gunpowder, and then cocking it, we tied to the tricker one end of a ſtring, whoſe other end was faſtened to the key formerly mentioned to belong to the cover of our receiver. This done, we conveyed the piſtol, together with the annexed ſtaff, into the veſſel; which being cloſed up, and emptied after the uſual manner, we began to turn the key in the cover; and there-

by ſhortening the ſtring that reached from it to the piſtol, we pulled aſide the tricker, and obſerved, that, according to our expectation, the force of the ſpring of the lock was not ſenſibly abated by the abſence of the air; (from whoſe *impetus* yet ſome modern naturaliſts would derive the cauſe of the motion of reſtitution in ſolid bodies.) For the cock falling with its wonted violence upon the ſteel, ſtruck out of it as many, and as conſpicuous parts of fire, as, for aught we could perceive, it would have done in the open air. Repeating this experiment divers times, we alſo obſerved, whether or no there would appear any conſiderable diverſity in the motion of the ſhining ſparks, in a place where the remaining air was ſo much rarefied, but could not perceive but that they moved ſome of them upwards, as well as ſome of them downwards, and ſome of them ſide-ways, as they are wont to do, when upon ſuch colliſions they fly out in the open air.

WE likewiſe cauſed a piece of ſteel to be made of the form and bigneſs of the flint, in whoſe place we put it, and then the piſtol being cocked and conveyed into the receiver, the tricker was pulled after the air was drawn out: and though the place were purpoſely ſomewhat darkened, yet there appeared not upon the ſtriking of the two ſteels againſt each other the leaſt ſpark of fire; nor did we expect any (having before in vain attempted to ſtrike fire this way in the open air) though we thought fit to make the experiment, to undeceive thoſe, who fancy in rarefied air, I know not what ſtrange diſpoſition, to take fire upon a much ſlighter occaſion than this experiment afforded. We have indeed found, that by the dextrous colliſion of two hardened pieces of ſteel, ſtore of ſparks may be ſtruck out: but that was done with ſuch vehement percuſſion of the edges of the two ſteels, as could not well be compaſſed in our receiver.

BUT the chief thing we deſigned to do with our piſtol, was, to obſerve, whether gunpowder would take fire in our emptied and cloſely ſtopped glaſs? whether the expanſion of the flame would be conſiderably varied by the abſence of ſo much of the ambient air as was drawn out of the receiver? and whether the flame would diffuſe it ſelf upward, as it is wont, notwithſtanding its not having about it the uſual proportion of air to force it up? And though moſt of our attempts to fire the gunpowder in the pan of the piſtol ſucceeded not, becauſe we were fain to let it hang almoſt perpendicular in the receiver, whereby the powder was ſhaken down before the ſparks could reach it: yet once the experiment ſucceeded, and the kindled powder ſeemed to make a more expanded flame than it would have done in the open air, but mounted upwards according to its wont; whether by reaſon of that little portion of air, which in ſpight of our pumping remained in the receiver, or for any other cauſe, we have not now the leiſure to conſider. But we muſt not forget, that, upon the extinction of the flame, the receiver appeared darkened with ſmoak, which ſeemed to move freely up and down, and upon the letting in the air at the ſtop-cock, began to circulate much faſter than before. We would have made more obſervations concerning this flame, but that of two or three attempts we afterwards made to repeat the kindling of the powder, not any one ſucceeded; and we have not the leiſure to dwell long upon one kind of trials.

EXPERIMENT XV.

TO theſe experiments concerning fire we added another, which, though it ſucceeded not, may perhaps without impertinency be recorded; partly, becauſe that (as we have in another treatiſe amply declared) it is uſeful to recite what experiments miſcarry as well as ſucceed. And partly alſo, becauſe it is very poſſible, that what we endeavoured in vain, may be performed by your Lordſhip, or ſome other Virtuoſo, that ſhall have ſtancher veſſels than we had, and more ſunny days than the preſent winter allows us.

WE conveyed then into one of our ſmall receivers a piece of matter combuſtible, dry and black, (experience declaring things of that colour to be moſt eaſily kindled;) and carefully cloſing the veſſel, we brought it to a window, at which the ſun, not very far from the meridian, ſhone in very freely: then drawing out the air with ſpeed, we united the ſun-beams with a burning-glaſs upon the combuſtible matter, which began immediately to ſend forth a ſmoak that quickly darkened the receiver; but notwithſtanding all our care and diligence the external air got in ſo faſt, that after divers trials we were fain to leave off the experiment in that glaſs, and induced to make trial of it in our great receiver.

HAVING then after ſome difficulty lodged the combuſtible matter in the cavity of this veſſel in ſuch manner, as that it was almoſt contiguous to that ſide thereof that was next the ſun, we did endeavour with a pretty large burning-glaſs to kindle it; but found, as we feared, that, by reaſon of the thickneſs of the glaſs, (which was alſo of a leſs pure and leſs diaphanous matter than the other) the ſun-beams thrown in by the burning-glaſs, were in their paſſage ſo diſlocated and ſcattered (not now to mention thoſe many that, being reflected, could not pierce into the cavity of the receiver) that we could not poſſibly unite enough of them to kindle the matter, nor ſo much as to make it ſenſibly ſmoak. Yet we hope, that the ſeeing whether bodies (other than gun-powder) may be kindled, and what would happen to them, when ſet on fire in a place in great meaſure devoid of air, may prove ſo luciferous an experiment, that when the ſeaſon is more favourable, we ſhall, God permitting, make farther trial of it, and acquaint your Lordſhip with the event, if it

proves proſperous. In the mean time we ſhall paſs on to other experiments, as ſoon as we have advertiſed your Lordſhip, that we have forborn to make ſuch reflections upon the ſeveral experiments we have ſet down concerning fire, as the matter would have eaſily afforded, and your Lordſhip may perhaps have expected. But I made the leſs ſcruple to forbear the annexing of ſpeculations to theſe recitals, becauſe *Carneades* and *Eleutherius* have in ſome Dialogues concerning heat and flame, (which were laſt year ſeen by ſome friends, and may be, when you pleaſe, commanded by you,) mentioned divers of my thoughts and experiments concerning fire.

EXPERIMENT XVI.

WE deſigned to try, whether or no divers magnetical experiments would exhibit any unuſual phænomena, being made in our evacuated receiver inſtead of the open air: but for want of leiſure and conveniency to proſecute ſuch trials, we were induced to reſerve the reſt for another time, and to content our ſelves with making that which follows. We conveyed into the receiver a little pedeſtal of wood, in the midſt of which was perpendicularly erected a ſlender iron, upon whoſe ſharp point an excited needle of ſteel purpoſely made, and of about five inches long, was ſo placed, that hanging in an æquilibrium it could move freely towards either hand. Then the air being after the uſual manner pumped out, we applied a load-ſtone moderately vigorous to the outſide of the glaſs, and found, that it attracted or repelled the ends of the needle, according to the laws magnetical, without any remarkable difference from what the ſame load-ſtone would have done, had none of the air been drawn away from about the needle; which, when the load-ſtone was removed, after ſome tremulous vibrations to and fro, reſted in a poſition, wherein it looked north and ſouth.

EXPERIMENT XVII.

PROCEED we now to the mention of that experiment, whereof the ſatisfactory trial was the principal fruit I promiſed my ſelf from our engine, it being then ſufficiently known, that in the experiment *de vacuo*, the quickſilver in the tube is wont to remain elevated, above the ſurface of that whereon it leans, about 27 digits. I conſidered, that, if the true and only reaſon why the quickſilver falls no lower, be, that at that altitude the mercurial cylinder in the tube is in an æquilibrium with the cylinder of air ſuppoſed to reach from the adjacent mercury to the top of the atmoſphere; then if this experiment could be tried out of the atmoſphere, the quickſilver in the tube would fall down to a level with that in the veſſel, ſince then there would be no preſſure upon the ſubjacent, to reſiſt the weight of the incumbent mercury. Whence I inferred (as eaſily I might) that if the experiment could be tried in our engine, the quickſilver would ſubſide below 27 digits, in proportion to the exſuction of air, that ſhould be made out of the receiver. For, as when the air is ſhut into the receiver, it doth (according to what hath above been taught) continue there as ſtrongly compreſſed, as it did whilſt all the incumbent cylinder of the atmoſphere leaned immediately upon it; becauſe the glaſs, wherein it is penned up, hinders it to deliver it ſelf, by an expanſion of its parts, from the preſſure wherewith it was ſhut up. So if we could perfectly draw the air out of the receiver, it would conduce as well to our purpoſe, as if we were allowed to try the experiment beyond the atmoſphere.

WHEREFORE (after having ſurmounted ſome little difficulties, which occurred at the beginning) the experiment was made after this manner: we took a ſlender and very curiouſly blown cylinder of glaſs, of near three foot in length, and whoſe bore had in diameter a quarter of an inch, wanting a hair's breadth: this pipe being Hermetically ſealed at one end, was, at the other, filled with quickſilver, care being taken in the filling, that as few bubbles as was poſſible ſhould be left in the mercury. Then the tube being ſtopt with the finger and inverted, was opened, according to the manner of the experiment, into a ſomewhat long and ſlender cylindrical box (inſtead of which we now are wont to uſe a glaſs of the ſame form) half filled with quickſilver: and ſo, the liquid metal being ſuffered to ſubſide, and a piece of paper being paſted on level with its upper ſurface, the box and tube and all were by ſtrings carefully let down into the receiver: and then, by means of the hole formerly mentioned to be left in the cover, the ſaid cover was ſlipt along as much of the tube as reached above the top of the receiver; and the interval, left betwixt the ſides of the hole and thoſe of the tube, was very exquiſitely filled up with melted (but not over-hot) diachylon, and the round chink, betwixt the cover and the receiver, was likewiſe very carefully cloſed up: upon which cloſure there appeared not any change in the height of the mercurial cylinder, no more than if the interpoſed glaſs-receiver did not hinder the immediate preſſure of the ambient atmoſphere upon the incloſed air; which hereby appears to bear upon the mercury, rather by virtue of its ſpring than of its weight; ſince its weight cannot be ſuppoſed to amount to above two or three ounces, which is inconſiderable in compariſon of ſuch a cylinder of mercury as it would keep from ſubſiding.

ALL things being thus in a readineſs, the ſucker was drawn down; and, immediately upon the egreſs of a cylinder of air out of the receiver, the quickſilver in the tube did, according to expectation, ſubſide: and notice being carefully taken (by a mark faſtened to the outſide) of the place where it ſtopt, we cauſed him that managed the pump to pump again, and marked how low the quickſilver fell at the ſecond exſuction; but continuing

this work, we were quickly hindered from accurately marking the ſtages made by the mercury, in its deſcent, becauſe it ſoon ſunk below the top of the receiver, ſo that we could henceforward mark it no other ways than by the eye. And thus, continuing the labour of pumping for about a quarter of an hour, we found our ſelves unable to bring the quickſilver in the tube totally to ſubſide; becauſe, when the receiver was conſiderably emptied of its air, and conſequently that little that remained grown unable to reſiſt the irruption of the external, that air would (in ſpight of whatever we could do) preſs in at ſome little avenue or other; and though much could not thereat get in, yet a little was ſufficient to counterbalance the preſſure of ſo ſmall a cylinder of quickſilver, as then remained in the tube.

NOW (to ſatisfy our ſelves farther, that the falling of the quickſilver in the tube to a determinate height, proceedeth from the æquilibrium, wherein it is at that height with the external air, the one gravitating, the other preſſing with equal force upon the ſubjacent mercury) we returned the key and let in ſome new air; upon which the mercury immediately began to aſcend (or rather to be impelled upwards) in the tube, and continued aſcending, till, having returned the key, it immediately reſted at the height which had then attained: and ſo, by turning and returning the key, we did ſeveral times at pleaſure impel it upwards, and check its aſcent. And laſtly, having given a free egreſs at the ſtop-cock to as much of the external air as would come in, the quickſilver was impelled up almoſt to its firſt height: I ſay almoſt, becauſe it ſtopt near a quarter of an inch beneath the paper-mark formerly mentioned; which we aſcribed to this, that there was (as is uſual in this experiment) ſome little particles of air engaged among thoſe of the quickſilver; which particles, upon the deſcent of the quickſilver, did manifeſtly riſe up in bubbles towards the top of the tube, and by their preſſure, as well as by leſſening the cylinder by as much room as they formerly took up in it, hindered the quickſilver from regaining its firſt height.

THIS experiment was a few days after repeated, in the preſence of thoſe excellent and deſervedly famous Mathematick Profeſſors, Dr. *Wallis*, Dr. *Ward*, and Mr. *Wren*, who were pleaſed to honour it with their preſence; and whom I name, both as juſtly counting it an honour to be known to them, and as being glad of ſuch judicious and illuſtrious witneſſes of our experiment: and it was by their gueſs, that the top of the quickſilver in the tube was defined to be brought within an inch of the ſurface of that in the veſſel.

AND here, for the illuſtration of the foregoing experiment, it will not be amiſs to mention ſome other particulars relating to it.

FIRST then, when we endeavoured to make the experiment with the tube cloſed at one end with diachylon inſtead of an Hermetical ſeal, we perceived, that upon the drawing of ſome of the air out of the receiver, the mercury did indeed begin to fall, but continued afterwards to ſubſide, though we did not continue pumping. When it appeared, that though the diachylon, that ſtopt the end of the tube, were ſo thick and ſtrong, that the external air could not preſs it in, (as experience taught us that it would have done, if there had been but little of it;) yet the ſubtler parts of it were able (though ſlowly) to inſinuate themſelves through the very body of the plaiſter, which it ſeems was not of ſo cloſe a texture, as that which we mentioned our ſelves to have ſucceſsfully made uſe of, in the experiment *de vacuo* ſome years ago. So that now we begin to ſuſpect, that perhaps one reaſon, why we cannot perfectly pump out the air, may be, that when the veſſel is almoſt empty, ſome of the ſubtler parts of the external air may, by the preſſure of the atmoſphere, be ſtrained through the very body of the diachylon into the receiver. But this is only conjecture.

ANOTHER circumſtance of our experiment was this, that if (when the quickſilver in the tube was fallen low) too much ingreſs were, at the hole of the ſtop-cock, ſuddenly permitted to the external air; it would ruſh in with that violence, and bear ſo forcibly upon the ſurface of the ſubjacent quickſilver, that it would impel it up into the tube rudely enough to endanger the breaking of the glaſs.

WE formerly mentioned, that the quickſilver did not, in its deſcent, fall as much at a time, after the two or three firſt exſuctions of the air, as at the beginning. For, having marked its ſeveral ſtages upon the tube, we found, that at the firſt ſuck it deſcended an inch and $\frac{3}{8}$, and at the ſecond an inch and $\frac{3}{8}$; and when the veſſel was almoſt emptied, it would ſcarce at one exſuction be drawn down above the breadth of a barley-corn. And indeed we found it very difficult to meaſure, in what proportion theſe decrements of the mercurial cylinder did proceed; partly, becauſe (as we have already intimated) the quickſilver was ſoon drawn below the top of the receiver; and partly becauſe, upon its deſcent at each exſuction, it would immediately re-aſcend a little upwards; either by reaſon of the leaking of the veſſel at ſome imperceptible hole or other, or by reaſon of the motion of reſtitution in the air, which, being ſomewhat compreſſed by the fall as well as weight of the quickſilver, would repel it a little upwards, and make it vibrate a little up and down, before they could reduce each other to ſuch an æquilibrium as both might reſt in.

BUT though we could not hitherto make obſervations accurate enough, concerning the meaſures of the quickſilver's deſcent, to reduce them into any hypotheſis, yet would we not diſcourage any from attempting it; ſince, if it could be reduced to a certainty, it is probable, that the diſcovery would not be unuſeful.

AND, to illuſtrate this matter a little more, we will add, that we made a ſhift to try the ex-

experiment in one of our above mentioned ſmall receivers, not containing a quart; but (agreeably to what we formerly obſerved) we found it as difficult to bring this to be quite empty as to evacuate the greater; the leaſt external air that could get in (and we could not poſſibly keep it all perfectly out) ſufficing, in ſo ſmall a veſſel, to diſplay a conſiderable preſſure upon the ſurface of the mercury, and thereby hinder that in the tube from falling to a level with it. But this is remarkable, that having two or three times tryed the experiment in a ſmall veſſel upon the very firſt cylinder of air that was drawn out of the receiver, the mercury fell in the tube 18 inches and a half, and another trial 19 inches and a half.

BUT on this occaſion, I hold it not unfit to give your Lordſhip notice, that I hoped from the deſcent of the quickſilver in the tube, upon the firſt ſuck, to derive this advantage; that I ſhould thence be enabled to give a nearer gueſs at the proportion of force betwixt the preſſure of the air (according to its various ſtates, as to denſi ty and rarefaction) and the gravity of quickſilver, than hitherto hath been done. For in our experiment there are divers things given, that may be made uſe of towards ſuch a diſcovery. For firſt, we may know the capacity of the receiver wherein the experiment is made, ſince, by filling it with water, we may eaſily compute how many quarts, or meaſures of any other denomination, it containeth of air; which air, when ſhut up in the veſſel, may be ſupppoſed to have a preſſure equal to that of the atmoſphere; ſince it is able to keep the quickſilver in the tube from falling any lower than it did in the free and open air. Next, here is given us the capacity of the braſs clyinder, emptied by the drawing down of the ſucker, (its bore and height being mentioned in the deſcription of our pump) whereby we may come to know how much of the air contained in the receiver is drawn out at the firſt ſuck. And we may alſo eaſily define, either in weight or cubick meaſures, the cylinder of quickſilver, that anſwers to the cylinder of air lately mentioned, (that mercurial cylinder being in our engine computable by deducting from the entire altitude of that cylinder of quickſilver, the altitude at which it reſts upon the firſt exſuction.) But though, if this experiment were very watchfully tryed in veſſels of ſeveral ſizes, and the various deſcents of the quickſilver compared among themſelves, it is not improbable, that ſome ſuch things, as we hoped for, may thereby be diſcovered. Yet, becauſe not only the ſolid contents of as much of the glaſs-tube as remains within the concave ſurface of the receiver, and (which is more difficult) the varying contents of the veſſel containing the mercury, and of as much of the mercury itſelf as is not in the tube, muſt be deducted out of the capacity of the receiver, but there muſt alſo an allowance be made for this, that the cylinder, that is emptied by the drawing down of the ſucker, and comes to be filled upon the letting of the air out of the receiver into it, is not ſo repleniſhed with air as the receiver itſelf at firſt was; becauſe there paſſeth no more air out of the receiver into the cylinder, than is requiſite to reduce the air in the cavity of the cylinder, and in that of the receiver to the ſame meaſure of dilatation. Becauſe of theſe (I ſay) and ſome other difficulties, that requiremore ſkill in mathematicks than I pretend to, and much more leiſure than my preſent occaſions would allow me, I was willing to refer the nicer conſideration of this matter to ſome of our learned and accurate mathematicians, thinking it enough for me to have given the hint already ſuggeſted.

FOR farther confirmation of what hath been delivered, we likwiſe tried the experiment in a tube of leſs than two foot long: and, when there was ſo much air drawn out of the veſſel, that the remaining air was not able to counterbalance the mercurial cylinder, the quickſilver in the tube ſubſided ſo viſibly, that (the experiment being tryed in the little veſſel lately mentioned) at the firſt ſuck it fell above a ſpan, and was afterwards drawn lower and lower for a little while; and the external air being let in upon it, impelled it up again almoſt to the top of the tube: ſo little matters it, how heavy or light the cylinder of quickſilver to ſubſide is, provided its gravity overpower the preſſure of as much external air as bears upon the ſurface of that mercury into which it is to fall.

LASTLY, we alſo obſerved, that if (when the mercury in the tube had been drawn down, and by an ingreſs permitted to the external air, impelled up again to its former height) there were ſome more air thruſt up by the help of the pump into the receiver, the quickſilver in the tube would aſcend much above the wonted height of 27 digits, and immediately upon the letting out of that air would fall again to the height it reſted at before.

YOUR Lordſhip will here perhaps expect, that as thoſe, who have treated of the Torricellian experiment, have for the moſt part maintained the affirmative, or the negative of that famous queſtion, whether or no that noble experiment infer a vacuum? ſo I ſhould on this occaſion interpoſe my opinion touching that controverſy; or at leaſt declare, whether or no, in our engine, the exſuction of the air do prove the place deſerted by the air ſucked out to be truly empty, that is, devoid of all corporeal ſubſtance. But beſides that I have neither the leiſure, nor the ability, to enter into a ſolemn debate of ſo nice a queſtion; your Lordſhip may, if you think it worth the trouble, in the Dialogues not long ſince referred to, find the difficulties on both ſides repreſented, which then made me yield but a very wavering aſſent to either of the parties contending about the queſtion: nor dare I yet take upon me to determine ſo difficult a controverſy.

FOR on the one ſide it appears, that notwithſtanding the exſuction of the air, our receiver may not be deſtitute of all bodies, ſince

any

any thing placed in it, may be ſeen there; which would not be, if it were not pervious to thoſe beams of light, which rebounding from the ſeen object to our eyes, affect us with the ſenſe of it: and that either theſe beams are corporeal emanations from ſome lucid body, or elſe at leaſt the light they convey doth reſult from the briſk motion of ſome ſubtle matter, I could, if I miſtake not, ſufficiently manifeſt out of the Dialogues above-mentioned, if I thought your Lordſhip could ſeriouſly imagine that light could be conveyed without, at leaſt, having, (if I may ſo ſpeak) a body for its vehicle.

BY the ſixteenth experiment, it alſo appears that the cloſeneſs of our receiver hinders it not from admitting the effluvia of the load-ſtone; which makes it very probable that it alſo freely admits the magnetical ſteams of the earth; concerning which, we have in another treatiſe endeavoured to manifeſt that numbers of them do always permeate our air.

BUT on the other ſide it may be ſaid, that as for the ſubtle matter which makes the objects encloſed in our evacuated receiver, viſible, and the magnetical effluvia of the earth that may be preſumed to paſs thorough it, though we ſhould grant our veſſel not to be quite devoid of them, yet we cannot ſo reaſonably affirm it to be repleniſhed with them, as we may ſuppoſe, that if they were gathered together into one place without intervals between them, they would fill but a ſmall part of the whole receiver. As in the thirteenth experiment, a piece of match was inconſiderable for its bulk, whilſt its parts lay cloſe together, that afterwards (when the fire had ſcattered them into ſmoke) ſeemed to repleniſh all the veſſel. For (as elſewhere our experiments have demonſtrated) both light and the effluvia of the load-ſtone may be readily admitted into a glaſs, hermetically ſealed, though before their admiſſion, as full of air as hollow bodies here below are wont to be; ſo that upon the exſuction of the air, the large ſpace deſerted by it, may remain empty, notwithſtanding the pretence of thoſe ſubtle corpuſcles, by which lucid and magnetical bodies produce their effects.

AND as for the allegations above mentioned, they ſeemed to prove but that the receiver devoid of air, may be repleniſhed with ſome etherial matter, as ſome modern Naturaliſts write of, but not that it really is ſo. And indeed to me it yet ſeems, that as to thoſe ſpaces which the Vacuiſts would have to be empty, becauſe they are manifeſtly devoid of air; and all groſſer bodies the Pleniſts (if I may ſo call them) do not prove that ſuch ſpaces are repleniſhed with ſuch a ſubtle matter as they ſpeak of, by any ſenſible effects, or operations of it (of which divers new trials purpoſely made, have not yet ſhewn me any) but only conclude that there muſt be ſuch a body, becauſe there cannot be a void. And the reaſon why there cannot be a void, being by them taken, not from any experiments, or phænomena of nature, that clearly and particularly prove their hypotheſis, but from their notion of a body, whoſe nature, according to them, conſiſting only in extenſion (which indeed ſeems the property moſt eſſential to, becauſe inſeparable from a body) to ſay a ſpace devoid of body, is, to ſpeak in the ſchoolmen's phraſe, a contradiction *in adjecto.*' This reaſon, I ſay, being thus deſumed, ſeems to make the controverſy about a vacuum rather a metaphyſical, than a phyſiological queſtion; which therefore we ſhall here no longer debate, finding it very difficult either to ſatisfy Naturaliſts with this Carteſian notion of a body, or to manifeſt wherein it is erroneous, and ſubſtitute a better in its ſtead.

BUT though we are unwilling to examine any farther the inferences wont to be made from the Torricellian experiment, yet we think it not impertinent to preſent your Lordſhip with a couple of advertiſements concerning it.

FIRST then, if in trying the experiment here or elſewhere, you make uſe of the Engliſh meaſures that mathematicians and tradeſmen are here wont to employ, you will, unleſs you be forewarned of it, be apt to ſuſpect that thoſe that have written of the experiment have been miſtaken. For whereas men are wont generally to talk of the quickſilver's remaining ſuſpended at the height of between ſix or ſeven and twenty inches; we commonly obſerved, when divers years ſince we firſt were ſolicitous about this experiment, that the quickſilver in the tube reſted at about 29 inches and a half above the ſurface of the reſtagnant quickſilver in the veſſel, which did at firſt both amaze and perplex us, becauſe though we held it not improbable that the difference of the groſſer Engliſh air, and that of Italy and France, might keep the quickſilver from falling quite as low in this colder, as in thoſe warmer climates; yet we could not believe that that difference in the air ſhould alone be able to make ſo great an one in the heights of the mercurial cylinders; and accordingly upon enquiry we found, that though the various denſity of the air be not to be overlooked in this experiment, yet the main reaſon why we found the cylinder of mercury to conſiſt of ſo many inches, was this, that our Engliſh inches are ſomewhat inferior in length to the digits made uſe of in foreign parts, by the writers of the experiment.

THE next thing I deſire your Lordſhip to take notice of, is, that the height of the mercurial cylinder is not wont to be found altogether ſo great as really it might prove, by reaſon of the negligence or incogitancy of moſt that make the experiment. For oftentimes upon the opening of the inverted tube into the veſſel'd mercury, you may obſerve a bubble of air to aſcend from the bottom of the tube through the ſubſiding quickſilver to the top; and almoſt always you may, if you look narrowly, take notice of a multitude of ſmall bubbles all along the inſide of the tube betwixt the quickſilver and the glaſs; (not now to mention the particles of air that lie concealed in the very body of the mercury:) many of which, upon the quickſilver's forſaking the upper part of the tube, do break into that deſerted ſpace where they find little or no reſiſtance to their expanding of themſelves. Whether this be the reaſon, that upon the application of warm bodies to the emptied part of the tube, the ſubjacent mercury would be depreſſed ſome-

what lower, we ſhall not determine; though it ſeem very probable, eſpecially ſince we found, that, upon the application of linen cloths dipped in water, to the ſame part of the tube, the quickſilver would ſomewhat aſcend; as if the cold had condenſed the impriſoned air (that preſſed upon it) into a leſſer room. But that the deſerted ſpace is not wont to be totally devoid of air, we were induced to think by ſeveral circumſtances: for when an eminent mathematician, and excellent experimenter, had taken great pains and ſpent much time in accurately-filling up a tube of mercury, we found that yet there remained ſtore of inconſpicuous bubbles, by inverting the tube, letting the quickſilver fall to its wonted height; and by applying (by degrees) a red-hot iron to the outſide of the tube, over againſt the upper part of the mercurial cylinder, (for hereby the little unheeded bubbles, being mightily expanded, aſcended in ſuch numbers, and ſo faſt to the deſerted ſpace, that the upper part of the quickſilver ſeemed, to our wonder, to boil.) We farther obſerved, that in the trials of the Torricellian experiment we have ſeen made by others, and (one excepted) all our own, we never found that, upon the inclining of the tube, the quickſilver would fully reach to the very top of the ſealed end: which argued, that there was ſome air retreated thither that kept the mercury out of the unrepleniſhed ſpace.

IF your Lordſhip ſhould now demand what are the beſt expedients to hinder the intruſion of the air in this experiment; we muſt anſwer, that of thoſe which are eaſily intelligible without ocular demonſtration, we can at preſent ſuggeſt, upon our own trials, no better than theſe. Firſt, at the open end of the tube the glaſs muſt not only be made as even at the edges as you can, but it is very convenient (eſpecially if the tube be large) that the bottom be every way bent inwards, that ſo the orifice, not much exceeding a quarter of an inch in diameter, may be the more eaſily and exactly ſtopped by the experimenter's finger; between which and the quickſilver, that there may be no air intercepted (as very often it happens that there is) it is requiſite that the tube be filled as full as poſſibly it can be, that the finger which is to ſtop it, preſſing upon the accumulated and protuberant mercury, may rather throw down ſome, than not find enough exactly to keep out the air. It is alſo an uſeful and compendious way not to fill the tube at firſt quite of mercury, but to leave near the top about a quarter of an inch empty; for if you then ſtop the open end with your finger, and invert the tube, that quarter of an inch of air will aſcend in a great bubble to the top, and in its paſſage thither, will gather up all the little bubbles, and unite them with itſelf into one great one; ſo that if by reinverting the tube, you let that bubble return to the open end of it, you will have a much cloſer mercurial cylinder than before, and need but to add a very little quickſilver more to fill up the tube exactly. And laſtly, as for thoſe leſſer and inconſpicuous parcels of air which cannot this way be gleaned up, you may endeavour, before you invert the tube, to free the quickſilver from them by ſhaking the tube, and gently knocking on the outſide of it, after every little parcel of quickſilver which you pour in; and afterwards, by forcing the ſmall latitant bubbles of air to diſcloſe themſelves and break, by imploying a hot iron in ſuch manner as we lately mentioned. I remember that by carefully filling the tube, though yet it were not quite free from air, we have made the mercurial cylinder reach to 30 inches and above an eighth, and this in a very ſhort tube: which we therefore mention, becauſe we have found, by experience, that in ſhort tubes a little air is more prejudicial to the experiment than in long ones, where the air having more room to expand it ſelf, doth leſs potently preſs upon the ſubjacent mercury.

AND ſince we are fallen upon the conſideration of the altitude of the mercurial cylinder, I muſt not conceal from your Lordſhip an experiment relating thereunto, which perhaps will ſet both you and many of your friends, the Vertuoſi, on thinking; and, by diſcloſing ſome things about the air or atmoſphere, that have ſcarce hitherto been taken notice of, may afford you ſome hint conducive to a further diſcovery of the ſubject of this epiſtle.

EXPERIMENT XVIII.

WE took a glaſs tube, which though it were not much above three foot long, we made choice of, becauſe it was of a more than ordinarily even thickneſs. This we filled with mercury, though not with as much care as we could, yet with ſomewhat more than is wont to be uſed in making the Torricellian experiment. Then having, according to the manner, inverted the tube, and opened the mouth of it beneath the ſurface of ſome other quickſilver, that in the tube fell down to the wonted height, leaving, as is uſual, ſome little particles of air in the ſpace it deſerted; as we gueſſed by obſerving, that upon the application of hot bodies to the upper part of the tube, the quickſilver would be a little depreſſed. Laſtly, having put both the tube and the veſſel it leaned on into a convenient wooden frame to keep them from miſchances; we placed that frame in a window within my bed-chamber, that I might both keep the mercury from being ſtirred, and have opportunity to watch from time to time the phænomena it was to exhibit. For the better diſcovery of which, when the quickſilver both in the tube and ſubjacent veſſel was perfectly at reſt, we took notice, by a mark made on the outſide of the glaſs, how high the included liquor then reached.

DURING ſeveral weeks that the tube was kept in that window, (which was very rarely opened) I had the opportunity to obſerve, that the quickſilver did ſometimes faintly imitate the liquor of a weather-glaſs, ſubſiding a little in warm, and riſing a little in cold weather; which we aſcribed to the greater or leſſer preſſure of that little air that remained at the top of the tube, expanded or condenſed by the heat or cold that affected the ambient air. But

that

that which I was chiefly careful to obſerve, was this, that oftentimes the quickſilver did riſe and fall in the tube, and that very notably, without conforming it ſelf to what is uſual in weather-glaſſes, whoſe air is at the top, nay quite contrary thereunto: for ſometimes I obſerved it in very cold weather (ſuch as this winter hath already afforded us good ſtore of) to fall down much lower than at other times, when by reaſon of the abſence of both froſt, ſnow, and ſharp winds, the air was comparatively much warmer. And I farther obſerved, that ſometimes the quickſilver would for ſome days together reſt almoſt at the ſame height; and at other times again it would in the compaſs of the ſame day conſiderably vary its altitude, though there appeared no change either in the air abroad, or in the temper of the air within the room (wherein was conſtantly kept a good fire) nor in any thing elſe, to which either I, or ſome eminently learned men, whom I then acquainted with the experiment, could reaſonably impute ſuch a change: eſpecially conſidering that the ſpace wherein the mercury wandred up and down, within about five weeks, amounted to full two inches, of which we found by our ſeveral marks whereby we had taken notice of its ſeveral removes, that it had deſcended about $\frac{9}{16}$ of an inch from the place where it firſt ſettled, and the other inch and $\frac{7}{16}$ it had aſcended. And it ſeems probable that the height of the mercurial cylinder would have varied yet more, if the experiment had been made in the open air, and in a long tube, where the particles of the impriſoned air, by having more room to diſplay themſelves in, might not have had ſo ſtrong a ſpring to work upon the quickſilver with. But for want both of time and of a competent quantity of mercury (which was not to be procured where we then happened to be) we were unable to make any farther trials: which therefore chiefly troubled us, becauſe we would gladly have tried an ingenious experiment which was ſuggeſted unto us by that excellent mathematician Mr. *Wren*, who being invited to name any thing he would have us try touching the preſſure of the air, deſired us to obſerve whether or no the quickſilver in a long tube would not a little vary its height according to the tides, eſpecially about the new and full moon; about which times mariners obſerve thoſe great flowings and ebbs of the ſea, that they call the ſpring-tides. For he ſagaciouſly and plauſibly conjectured that ſuch obſervations, accurately made, would diſcover the truth or erroneouſneſs of the Carteſian hypotheſis concerning the ebbing and flowing of the ſea: which *Des Cartes* aſcribeth to the greater preſſure made upon the air by the moon, and the intercurrent ethereal ſubſtance at certain times (of the day, and of the lunary month) than at others. But in regard we found the quickſilver in the tube to move up and down ſo uncertainly, by reaſon, as it ſeems, of accidental mutation in the air; I ſomewhat doubt whether we ſhall find the altitude of the quickſilver to vary as regularly as the experiment is ingeniouſly propoſed. The ſucceſs we ſhall (God permitting us to make trial of it) acquaint your Lordſhip with; and in the mean time take notice, that when we had occaſion to take the tube out of the frame (after it had ſtaid there part of *November* and and part of *December*) a good fire being then in the room, becauſe it was a ſnowy day, we found the quickſilver in the tube to be above the upper ſurface of the ſubjacent mercury 29 inches three quarters.

IF your Lordſhip ſhould now aſk me what are the true cauſes of this varying altitude of the mercurial cylinder; I ſhould not undertake to anſwer ſo difficult a queſtion, and ſhould venture ſo ſay no more, than that among divers poſſible cauſes to which it may be aſcribed, it would not be, perhaps, abſurd to reckon theſe that follow.

FIRST then, we may conſider, that the air in the upper part of the tube is much more rarefied, and therefore more weak than the external air, as may appear by this among other things, that upon the inclining of the tube, the quickſilver will readily aſcend almoſt to the very top of it, and ſo take up eight or nine tenth parts, and perhaps more of that ſpace which it deſerted before: which would not happen, if that whole ſpace had been full of unrarefied air, ſince that (as trial may eaſily ſatisfy you) would not have ſuffered itſelf to be thruſt into ſo narrow a room by ſo weak a preſſure. So that although in our tube when the included air was heated, the quickſilver was ſomewhat depreſſed; yet there is this difference betwixt ſuch a tube and common weather-glaſſes, that in theſe the included and the ambient air are in an æquilibrium as to preſſure, and the weight of the water that keeps them ſeparate is ſcarce conſiderable. Whereas in ſuch a tube as we are ſpeaking of, the air within is very much more dilated than that without. And it is not ſo much the ſpring or reſiſtance of the included air, as the weight of the mercurial cylinder it ſelf, that hinders the quickſilver from aſcending higher: for if we ſhould ſuppoſe that deſerted part of the tube perfectly devoid of air, yet would the quickſilver riſe but a little higher in it, and be far from filling it; in regard the outward air would not be able to impel up ſuch a weight much higher: whereas it may, by our former experiments appear, that if all the air in the upper part of the weather-glaſs were away, the water would be impelled up to the very top of it, though the pipe were above thirty foot long.

WE may next conſider, that this rarefied air, at the upper part of our tube, being exactly ſhut up betwixt the glaſs and the quickſilver, it was ſcarce ſubject to any diſcernable alterations, ſave thoſe it received from heat and cold.

AND we may farther conſider, that yet the external air or atmoſphere is ſubject to many alterations, beſides thoſe that proceed from either of thoſe qualities.

FOR the experiment that occaſioned this diſcourſe, ſeems to make it probable enough, that there may be ſtrange ebbings and flowings, as it were, in the atmoſphere, or at leaſt, that it may admit great and ſudden mutations, either

as to its altitude or its denſity, from cauſes, as well unknown to us, as the effects are unheeded by us. And that you may not think that there is nothing in nature but our experiment that agrees with this our conjecture, we might put your Lordſhip in mind of the pains and aches that are often complained of by thoſe that have had great wounds or bruiſes, and that do preſage great mutations in the air oftentimes, whilſt to ſtrong and healthy perſons no ſign of any ſuch thing appears. And that is alſo very memorable to this purpoſe, which I remember I have ſomewhere read in a book of the ingenious *Kirchèrus*, who giving a pertinent admonition concerning the various refractions that may happen in the air, relateth, that during his ſtay in *Malta*, he often ſaw mount *Ætna*, though the next day, notwithſtanding its being extremely clear, he could not ſee it; adding, that *Vinteмillius*, a very learned perſon, did oftentimes, from a hill he names, behold the whole iſland he calls *Luprica* protuberant above the ſea, though at other times, notwithſtanding a clear ſky, he could not ſee it. And though perhaps this may be in part aſcribed to the various light and poſition of the ſun, or to the various diſpoſition of the ſpectator's eye, or peradventure to ſome other cauſe; yet the moſt probable cauſe ſeems to be the differing denſity of the air, occaſioned by exhalations capable to increaſe the refraction, and conſequently bring beams to the eye, which otherwiſe would not fall on it. We have likewiſe, in another treatiſe, mentioned our having often obſerved with teleſcopes a plenty of ſteams in the air, which without ſuch a help would not be taken notice of, and which, as they were not at all times to be ſeen even through a teleſcope, ſo they did ſometimes, eſpecially after a ſhower of rain, haſtily diſappear: and when we have viſited thoſe places that abound with mines, we have ſeveral times been told by the diggers, that even when the ſky ſeemed clear, there would, not ſeldom, ſuddenly ariſe, and ſometimes long continue, a certain ſteam (which they uſually call a damp) ſo groſs and thick that it would oftentimes put out their very candles, if they did not ſeaſonably prevent it. And I think it will eaſily be granted, that the aſcenſion of ſuch ſteams into this or that part of the air, and their mixing with it, are very like to thicken it; as on the other ſide either heat or the ſudden condenſation of the air in another part of the atmoſphere (to mention now no other cauſes) are capable of rarefying it.

NOR will it very much import the main ſcope of our diſcourſe, whether it be ſuppoſed that the copious ſteams the earth ſends into the air, thicken that part of the atmoſphere that receives them, and make it more heavy; or that ſometimes the fumes may aſcend with ſuch celerity, that though the air be thickened, yet they rather diminiſh than encreaſe its gravitation, in regard that the quickneſs of their aſcent not only keeps them from gravitating themſelves, but may hinder the preſſing downwards of many aërial corpuſcles that they meet with in their way upwards. This, I ſay, is of no great importance to our preſent diſcourſe, ſince either way the terreſtrial ſteam may here and there conſiderably alter the gravity or preſſure of the atmoſphere.

YOUR Lordſhip may alſo be pleaſed to remember, that by our ſeventeenth experiment it appeared, that, as when the air in the receiver was expanded more than ordinarily, the quickſilver in the tube did proportionably ſubſide; ſo when the air in the ſame receiver was a little more than ordinarily compreſſed, it did impel up the quickſilver in the tube, above the wonted height of betwixt ſix and ſeven and twenty digits.

AND if to theſe things we annex, that, for aught we can find by trials purpoſely made, the degree of rarity or denſity of the air, ſhut up into our receiver, doth not ſenſibly alter its temperature as to cold or heat; it will not, I hope, appear abſurd to conceive, that ſince the air, included in the tube, could but very faintly hinder the aſcent of the quickſilver, or preſs it downwards; ſince too, that included air could ſcarce immediately receive any ſenſible alteration, ſave either by heat or cold; and ſince alſo, that according to the bare denſity or rarity of the air incumbent on the ſubjacent quickſilver in the veſſel, that in the tube was impelled more or leſs high; ſuch changes happening in the neighbouring part of the outward air, either by the aſcenſion of groſs or copious exhalations, or by any other cauſe (of which there may be divers) as were capable to make conſiderable alterations in the conſiſtence of the air, as to rarity and denſity, may be able proportionably to alter the height of the quickſilver: I rather ſay, that ſuch alterations may be, than that they are the cauſes of our phænomenon; becauſe I think it ſufficient, if I have propoſed conjectures not altogether irrational about a new myſtery of nature, touching which, the chief things I pretend to, is to give occaſion to the curious to enquire farther into it, than I have been yet able to do.

EXPERIMENT XIX.

THE ſame reaſon that moved us to conclude, that by the drawing of the receiver, the mercury would deſcend in a tube ſhorter than ſix and twenty digits, induced us alſo to expect, that by the ſame means water might be brought to ſubſide in glaſs-tubes of a moderate length: though by the noble experiment, ſaid to have been accurately made in *France*, by Monſieur *Paſchal*, we are informed that a tube of no leſs than about two and thirty foot, was found requiſite to make the experiment *de vacuo* ſucceed with water inſtead of quickſilver; ſo tall a cylinder of that lighter liquor being, it ſeems, requiſite to equal the weight of a mercurial cylinder of ſix or ſeven and twenty digits, and ſurmount the preſſure of the atmoſphere.

WE took then a tube of glaſs, hermetically ſealed at one end, of about four foot in length, and not very ſlender: this, at the open end, we filled with common water, and then ſtopped that end till we had inverted the tube,

and

and opened it beneath the ſurface of a quantity of the like water, contained in a ſomewhat deep and ſlender veſſel. This veſſel, with the tube in it, was let down into the receiver, and the receiver being cloſed up after the accuſtomed manner, the pump was ſet on work.

As much of the event as concerns our preſent purpoſe, was this, that till a conſiderable part of the air was drawn out of the receiver, the tube continued top full of water as when it was put in, it being requiſite that a great part of the air, formerly contained in the receiver, ſhould be drawn out, to bring the remaining air to an æquilibrium, with ſo ſhort and light a cylinder of water. But when once the water began to fall in the tube, then each exſuction of air made it deſcend a little lower, though nothing near ſo much as the quickſilver at the beginning did in the experiment formerly mentioned. Nor did there appear ſo much inequality in the ſpaces tranſmitted by the water in its deſcent, as there did in thoſe obſerved in the fall of the quickſilver; of which the cauſe will ſcarce ſeem abſtruſe to him that ſhall duly reflect upon what hath been already delivered. And whereas we drew down the quickſilver in the tube ſo far, as to bring it within an inch of the ſurface of the other quickſilver into which it was to fall; the loweſt we were able to draw down the water was, by our conjecture, to about a foot or more above the ſurface of that in the veſſel; of which I know not whether it will be needful to aſſign ſo obvious a cauſe as that, though the little air remaining in the receiver could not hinder a cylinder of above an inch high of quickſilver from ſubſiding; yet it might be very well able, by its preſſure, to countervail the weight of a cylinder of a foot long or more, of a liquor ſo much leſs ponderous than quickſilver, as water is. And in fine, to conclude our experiment, when the water was drawn down thus low, we found, that by letting in the outward air, it might be immediately impelled up again to the higher parts of the tube.

WE will add no more concerning this experiment, ſave that having tried it in one of our ſmall receivers, we obſerved, that upon the firſt exſuction of the air the water did uſually ſubſide divers inches, and at the ſecond (exſuction) fall down much lower, ſubſiding ſometimes near two foot; as alſo that upon the letting in of the air from without, the water was impelled up with very great celerity.

EXPERIMENT XX.

THAT the air hath a notable elaſtical power (whenceſoever that proceeds) we have, I ſuppoſe, abundantly evinced, and it begins to be acknowledged by the eminenteſt modern Naturaliſts. But whether or no there be in water ſo much as a languid one, ſeems hitherto to have been ſcarce conſidered, nor hath been yet, for aught I know, determined either way by any writer; which invited us to make the following experiment.

THERE was taken a great glaſs-bubble, with a long neck, (ſuch as chymiſts are wont to call a philoſophical egg;) which being filled with common water till the liquor reached about a ſpan above the bubble, and a piece of paper being there paſted on, was put unſtopped into the receiver, and then the air was ſucked out after the wonted manner. The event was this, that a conſiderable part of the air, penned up in the receiver, was drawn out, before we diſcerned any expanſion of the water: but, continuing the labour of pumping, the water manifeſtly began to aſcend in the ſtem of the glaſs, and divers bubbles looſening themſelves from the lower parts of the veſſel, made their way through the body of the water, to the top of it, and there brake into the receiver: and after the water once appeared to ſwell, then at each time the ſtop-cock was turned to let out the air from the receiver into the pump, the water in the neck of the glaſs did ſuddenly riſe about the breadth of a barley-corn in the neck of the glaſs, and ſo attained by degrees to a conſiderable height above the mark formerly mentioned. And at length (to make the expanſion of the water more evident) the outward air was ſuddenly let in, and the water immediately ſubſided, and deſerted all the ſpace it had newly gained in the glaſs.

AND, on this occaſion, it will not perhaps be amiſs to acquaint your Lordſhip here (though we have already mentioned it in another paper, to another purpoſe) with another expedient that we made uſe of two or three years ago, to try whether or no water had a ſpring in it. About that time then, that great and learned promoter of experimental philoſophy Dr. *Wilkins*, doing me the honour to come himſelf, and bring ſome of his inquiſitive friends to my lodging, we there had in readineſs a round and hollow veſſel of pewter, great enough to contain two pounds of water, and exactly cloſe every where but at one little hole where it was to be filled; then partly by ſucking out the air, and partly by injecting water with a ſyringe, it was (not without ſome difficulty) filled up to the top; and that hole being placed directly upwards, there was a little more water leiſurely forced in by the ſyringe. Upon which, though the veſſel were permitted to reſt, and the hole kept in its former poſture, yet the compreſſed water leiſurely ſwelled above the orifice of the hole, and divers drops ran over along the ſides of the veſſel. After this we cauſed a ſkilful pewterer (who had made the globe) to cloſe it up in our preſence with ſoder ſo exquiſitely, that none ſuſpected there was any thing left in it beſides water. And laſtly, the veſſel thus ſodered up, was warily and often ſtruck in divers places with a wooden mallet, and thereby was manifeſtly compreſſed, whereby the incloſed water was crouded into leſs room than it had before: and thereupon we took a needle, and with it and the mallet perforated the veſſel, and drew out the needle again; the water (but in a very ſlender ſtream) was ſuddenly thrown after it into the air, to the height of two or three feet. As for the other phænomena of this experiment, ſince they belong not to our preſent purpoſe, and are partly mentioned in another of our papers,

we ſhall, inſtead of recording them here, give this advertiſement: That as evidently as this experiment, and that made in our receiver, ſeem to prove a power in the water to expand and reſtore it ſelf after compreſſion; yet for a reaſon to be met with ere long, I judged it not ſafe to infer that concluſion from theſe premiſes, till I had made ſome of the following trials, to the mention of which I will therefore haſten.

EXPERIMENT XXI.

TO diſcover whether the expanſion of the water really proceeded from an elaſtical power in the parts of the water itſelf, we thought it requiſite to try two things: the one, whether or no the atmoſphere gravitates upon bodies under water; and the other, whether in caſe it do gravitate, the intumeſcence of the water may not be aſcribed to ſome ſubſtance ſubtler than itſelf, reſiding in it. In order to the ſatisfying my ſelf about the firſt of theſe, I intended to let down into the receiver a veſſel of water, wherein ſhould be immerſed a very ſmall oiled bladder, almoſt devoid of air, but ſtrongly tyed up at the neck with a ſtring, and detained a little under water by ſuch a weight faſtened to that ſtring, as ſhould juſt be able to keep the bladder from ſwimming, and no more. For I ſuppoſed, that if when all things were thus ordered, the receiver were emptied, in caſe there were any ſuch preſſure of the atmoſphere upon water, as I was inclined to believe, the air within the bladder, being, upon the exſuction of the air within the receiver, freed from that preſſure, and being preſſed only by the ſmall weight of the incumbent water, would conſiderably expand it ſelf; but whilſt we were preparing bladders for this experiment, there occurred an eaſy way for the making at once both the diſcoveries I deſired.

WE took then a glaſs phial, containing by gueſs a pound and ſome ounces of water; this we filled top full, and then we put into the neck of it a glaſs pipe a pretty deal bigger than a gooſe-quill, open at both ends, and of divers inches in length: one end of this pipe was ſo put into the neck of the phial, as to reach a little below it, and then was carefully cemented thereto, that no air might get into the phial, nor any water get out of it, otherwiſe than through the pipe; and then the pipe being warily filled, about half way up to the top, with more water, and a mark being paſted over againſt the upper ſurface of the liquor, the phial thus fitted with the pipe, was, by ſtrings let down into the receiver, and according to the wonted manner exquiſitely cloſed up in it.

THIS done, we began to pump out the air, and when a pretty quantity of it had been drawn away, the water in the pipe began to riſe higher in the pipe, at the ſides of which ſome little bubbles diſcovered themſelves. After a little while longer, the water ſtill ſwelling, there appeared at the bottom of the pipe a bubble about the bigneſs of a ſmall pea, which aſcending through the pipe to the top of the water, ſtayed there a while and then broke; but the pump being nimbly plyed, the expanſion of the water ſo increaſed, that quickly, getting up to the top of the pipe, ſome drops of it began to run down along the outſide of it; which obliged us to forbear pumping a while, and give the water leave to ſubſide within leſs than two inches of the bottom of the pipe. After this the pump being again ſet on work, the bubbles began to aſcend from the bottom of the pipe, being not all of a ſize, but yet ſo big, that eſtimating one with another, they appeared to be of the ſize of the ſmaller ſort of peas; and of theſe we reckoned about ſixty which came up one after another, beſides ſtore of ſmaller ones, of which we made no reckoning. And at length, growing weary of reckoning and pumping too (becauſe we found, that in ſpight of all our pains and induſtry, ſome undiſcerned leak or other in the receiver hindered us from being able to empty it altogether) we thought fit to deſiſt for that time, after trial made of what operation the external air, being let in upon the expanded water, would have; and accordingly turning the key to let in the air, we ſaw, as we expected, that the water in the pipe in a moment fell down almoſt to the bottom of it.

Now of this experiment there are two or three circumſtances yet to be mentioned, which are, no leſs than thoſe already recited, pertinent to our preſent purpoſe.

IN the firſt place then, when the greater part of the air had been pumped out of the receiver, the riſing bubbles aſcended ſo very ſlow in the pipe, that their progreſs was ſcarce diſcernable; which ſeemed to proceed from this, that their bigneſs was ſuch, that they could not ſufficiently extend themſelves in the cavity of the glaſs, without preſſing on both hands againſt the ſides of it, whereby they became of more difficult extruſion to the water. And though it may ſeem ſtrange that theſe bubbles ſhould be of any conſiderable bulk, ſince it is like they conſiſted of leſſer parcels of the air lurking in the water, than thoſe that were vigorous enough to make their way through, long before them; yet they were commonly much larger than before, ſome of them being equal in quantity to four or five peas; whether this their increaſe of bulk proceeded from the greater decrement of the preſſure of the air, or from the union of two or three of thoſe numerous bubbles which were then generated below the bottom of the pipe, where we could not ſee what was done among them.

ANOTHER thing we noted in our bubbles was, that whereas in ordinary ones the air, together with the thin film of water that inveſts and detains it, is wont to ſwell above the ſurface of the water it ſwims on, and commonly to conſtitute hemiſpherical bodies with it, the little parcels of air that came up after the receiver was pretty well emptied, did not make protuberant bubbles, but ſuch whoſe upper ſurface was either level with, or beneath that of the water; ſo that the upper ſurface being uſually ſomewhat convex, the leſs protuberant parts of it had a pretty quantity of water remaining above them.

WE alſo farther obſerved, that whereas in the bubbles

bubbles that firſt appeared in the pipe, the aſcending air did, as in other common bubbles, make its way upwards, by dividing the water through which it paſſed, in thoſe bubbles that appeared at the latter end of our experiment, when the preſſure of the little external air, remaining in the receiver, was grown inconſiderable; the aſcending parcels of air having now little more than the weight of the incumbent water to ſurmount, were able both ſo to expand themſelves as to fill up that part of the pipe which they pervaded, and by preſſing every way againſt the ſides of it, to lift upwards with them what water they found above them, without letting any conſiderable quantity glide down along the ſides of the glaſs: ſo that ſometimes we could ſee a bubble thruſt on before it a whole cylinder of water of perhaps an inch high, and carry it up to the top of the pipe; though, as we formerly noted, upon the letting in the external air, theſe tumid bubbles ſuddenly relapſed to their former inconſpicuouſneſs.

ALL theſe things laid together ſeemed ſufficiently to confirm that, which the conſideration of the thing it ſelf would eaſily enough perſuade; namely, that the air, and ſuch like bodies being under water, may be preſſed upon as well by the atmoſphere, as by the weight of the incumbent water it ſelf.

HENCE likewiſe we may verify what we obſerved at the cloſe of the foregoing experiment; namely, that from the ſole ſwelling of water there recorded, it cannot be ſo ſafely concluded, that water, when freed from compreſſion, is endowed with an elaſtical power of expanding it ſelf: ſince thereby it appears that the intumeſcence produced by that experiment, may (at leaſt in great part) be aſcribed to the numerous little bubbles which are wont to be produced in water, from which the preſſure of the atmoſphere is in great meaſure taken off. So apt are we to be miſ-led, even by experiments themſelves, into miſtakes, when either we conſider not that moſt effects may proceed from various cauſes, or mind only thoſe circumſtances of our experiment, which ſeem to comply with our preconceived hypotheſis or conjectures.

AND hence it ſeems alſo probable, that in the pores or inviſible little receſſes of water it ſelf there lie commonly interſperſed many parcels of either air, or at leaſt ſomething analogous thereunto, although ſo very ſmall, that they have not been hitherto ſo much as ſuſpected to lurk there. But if it be demanded how it appears that there is interſperſed through the body of water any ſubſtance thinner than it ſelf, and why that which produced the bubbles above mentioned ſhould not be reſolutely ſaid to be nothing elſe than a more active and ſpirituous part of the water; we ſhall, in order to the elucidation of this matter, ſubjoin, to what was formerly delivered, the following experiment.

EXPERIMENT XXII.

WE recited in our nineteenth experiment, how by drawing moſt of the air out of the receiver, we made the water ſubſide by degrees in a glaſs not four foot long: we ſhall now add, that in the like experiment made in ſuch a tube, or a greater, it may be obſerved, that when the water begins to fall, there will appear ſtore of bubbles faſtened all along to the ſides of the glaſs; of which bubbles, by the agitation of the veſſel conſequent upon pumping, there will ariſe good numbers to the top of the water, and there break; and as the cylinder of water is brought to be lower and lower, ſo the bubbles will appear more numerous in that part of the tube which the water yet fills; and the nearer the ſurface of the water, in its deſcent, approacheth to theſe bubbles, the greater they will grow, becauſe having the leſs weight and preſſure upon them, the expanſion of that air which makes them, can be the leſs reſiſted by the preſſure of the incumbent water and air; as ſeems probable from hence, that upon the letting in a little external air, thoſe bubbles immediately ſhrink.

IT may indeed, as we lately intimated, be conjectured, that theſe bubbles proceed not ſo much from any air pre-exiſtent in the water, and lurking in the pores of it, as from the more ſubtle parts of the water it ſelf; which, by the expanſion allowed them upon the diminiſhed preſſure of the ambient bodies, may generate ſuch bubbles. And indeed, I am not yet ſo well ſatisfied that bubbles may not (at leaſt ſometimes) have ſuch an origination: but that which makes me ſuſpect that thoſe in our trials contain real air, formerly latitant in the pores of the water, is this, that upon the inletting of the external air, the water was not again impelled to the very top of the tube whence it began to fall, but was ſtopped in its aſcent near an inch beneath the top. And ſince, if the upper part of the tube had been devoid of any other than ſuch ethereal matter as was ſubtle enough freely to penetrate the pores of the glaſs, the external air would have been able to impel the water to the top of a tube ſeven or eight times as long as ours was; the phænomenon under conſideration ſeemed manifeſtly to argue, that the many bubbles that broke at the top of the water, did contain a real air, which being collected into one place, and hindered by the top of the glaſs from receding, was able to withſtand the preſſure of the outward air. As we ſee that if never ſo little air remain in the tube upon the making the experiment *de vacuo* with quick-ſilver, no inclining of the tube, (though a long one) will enable a man to impel the mercury up to the very top, by reaſon (as we formerly noted) of the reſiſtance of the included air, which will not be compreſſed beyond a certain degree.

BUT in order to a farther diſcovery what our bubbles were, we will, on this occaſion, inform your Lordſhip, that we tried the XIXth experiment in one of our ſmall receivers, and found, that upon the drawing down of the water, ſo many bubbles diſcloſed themſelves, and broke into the upper part of the tube, that having afterwards let in the external air, the water was not thereby impelled to the top of the

the tube (three foot in length) within a little more than half an inch. And whether or no it were air that poſſeſſed that ſpace at the top of the tube, which was not filled with water, we took this courſe to examine. We drew the ſecond time the air out of the receiver, and found, that by reaſon of the body that poſſeſſed the top of the tube, we were able not only to make the water in the tube fall to a level with the ſurface of the water in the veſſel, but alſo (by plying the pump a little longer) a great way beneath it; which, ſince it could not well be aſcribed to the bare ſubſiding of the water, by reaſon of its own weight, argued that the water was depreſſed by the air: which was confirmed by the figure of the ſurface of the water in the tube, which was much more concave than that of water in tubes of that bigneſs uſeth to be. And this farther trial (to add that upon the bye) we made at the ſame time; that when the water in the pipe was drawn down almoſt as low as the water without it, we obſerved, that (though we deſiſted from pumping) by the bare application of a hand moderately warm to the deſerted part of the tube, the remaining water would be ſpeedily and notably depreſſed. And having for a while held a kindled coal to the outſide of the tube, (the pump being ſtill unimployed, becauſe the veſſel chanced to hold extraordinarily well) the air was by the heat ſo far expanded, that it quickly drove the water to the bottom of the tube, which was divers inches beneath the ſurface of the ambient water. Whereby it appears (by the ſame way by which we formerly meaſured the dilatation of the air) that the air, even when it is expanded to between 90 and 100 times its extent, will yet readily admit of a much farther rarefaction by heat.

I conſidered alſo that in caſe the bubbles we have been ſpeaking of, were produced by the parcels of air latitant in the water, that air being now got together to the top of the tube, though the air were again drawn out of the receiver, the taking off its preſſure would not diſcloſe bubbles as before; and accordingly, the air being again pumped out, the water in the tube deſcended as formerly: but for a great while we ſcarce ſaw one bubble appear, only when the receiver had been very much exhauſted, and the water was fallen very low, there appeared near the bottom of the tube, certain little bubbles, which ſeemed to conſiſt of ſuch parcels of air as had not, by reaſon of their ſmallneſs, got up to the top of the water, with the more bulky and vigorous ones. And that which is not inconſiderable, is, that having, by letting in the air, forced up the water into the tube, we could not perceive that it aſcended near the top, though we permitted the engine to remain unimployed for two or three nights together, and watched whether the water would ſwell up and fill the tube. And on this occaſion I remember, that having tried ſuch an experiment as this with quickſilver inſtead of water, in a tube of about a foot and a half long, wherein it might ſeem more hopeful to eſcape bubbles; yet upon the drawing down the quickſilver as low as we could, and letting in the external air upon it, we found that ſome lurking particles of air were got up to the top of the tube, and hindered the quickſilver from being forced up again ſo high. And though the quickſilver were by this means brought to appear a very cloſe and lovely metalline cylinder, not interrupted by interſperſed bubbles as before; yet having cauſed the air to be again drawn out of the receiver, I could perceive ſeveral little bubbles to diſcloſe themſelves, faſtened to the inſide of the tube, near the bottom of it; and having purpoſely watched one or two of the chiefeſt, I had the pleaſure to obſerve, that though they grew bigger and bigger as the ſurface of the mercurial cylinder fell nearer and nearer to them, ſo as that at length they ſwelled into a conſpicuous bulk; yet upon the wary letting in the air upon them, they did not break, but preſently ſhrunk up into a littleneſs that rendered them inconſpicuous.

WHENCE it ſeems very probable, if not certain, that even in the cloſeſt and moſt ponderous liquors, and therefore much more in water, there may lurk undiſcernable parcels of air, capable, upon the removal of the preſſure of the ambient air (though but in part) and that of the liquor wherein it lurks, to produce conſpicuous bubbles. And conſequently, if it ſeem inconvenient to admit an elaſtical power in the water, it may be ſaid that the ſwelling of the compreſſed water in the pewter veſſel lately mentioned, and the ſpringing up of the water at the hole made by the needle, were not the effects of any internal *Elater* of the water, but of the ſpring of the many little particles of air diſperſed through that water, and acting upon it in their ſudden recovering themſelves to a greater extent, than that to which a violent compreſſion had reduced them.

BUT though, from all theſe particulars, it ſeems manifeſt that the bubbles we have been all this while treating of, were produced by ſuch a ſubſtance as may be properly enough called air; yet till we ſhall have had the opportunity of making ſome farther trials concerning the nature of the air, we ſhall not reſolutely determine whether or no air be a primogenial body (if I may ſo ſpeak) that cannot now be generated or turned either into water or any other body. Yet in the mean while (becauſe it is an important queſtion, and, if rightly determined, may much conduce to the knowledge of the nature of the air) we think it not unfit to make a brief mention of ſome of the particulars which at preſent occur to our thoughts in favour of either part of the queſtion.

FIRST then, divers Naturaliſts eſteem the air (as well as other elements) to be ingenerable and incorruptible. And reaſons plauſible enough may be drawn to countenance this opinion, from the conſideration of that permanency that ought to belong to the corporeal principles of other bodies.

NEXT, experience may be pleaded to the ſame purpoſe, for I have read of ſome who in vain attempted to turn air into water, or water into air.

THE

Schottus Mechan. hydraulico-pneumat. Part 3. Claſſ. 1.

THE diligent *Schottus* tells us, that amongſt other rarities to be met with in that great repoſitory of them, the *Muſæum Kircherianum*, there is a round glaſs with a tapering neck near half full (as one may gueſs by the ſcheme he annexeth) of ordinary ſpring-water, which having been hermetically ſhut up there by *Clavius* the famous geometrician, the included water is to this day preſerved, not only clear and pure, as if it were but newly put in; but (as it ſeems) without (in the leaſt) turning into air, notwithſtanding its having been kept there theſe fifty years: for he tells us, that the water hath continued there all this while without any diminution.

NOR doth it appear in thoſe glaſſes, which for chymical experiments we uſually cloſe with *Hermes* his ſeal (as they call it) that the included air doth, during its long impriſonment, notwithſtanding the alteration it receiveth from various degrees of heat, diſcernably alter its nature. Whereas we plainly perceive in our digeſtions and diſtillations, that though water may be rarefied into inviſible vapours, yet it is not really changed into air, but only divided by heat, and ſcattered into very minute parts, which meeting together in the alembick or in the receiver, do preſently return into ſuch water as they conſtituted before. And we alſo ſee, that even ſpirit of wine, and other ſubtle and fugitive ſpirits, though they eaſily fly into the air, and mingle with it, do yet in the glaſſes of chymiſts eaſily lay aſide the diſguiſe of air, and reſume the diveſted form of liquors. And ſo volatile ſalts, as of urine, hartſhorn, *&c.* though they will readily diſperſe themſelves through the air, and play up and down in the capacity of an alembick or a receiver; yet will they, after a while, faſten themſelves to the inſides of ſuch glaſſes in the form of ſalts.

BESIDES, ſince air is confeſſedly endowed with an elaſtical power that probably proceeds from its texture, it appears not what it is, that in ſuch light alterations of water, as are by many preſumed capable of turning it into air, can be reaſonably ſuppoſed ſo to contrive the particles of water, as to give them, (and that permanently,) the ſtructure requiſite to a ſpring. I add the word permanently, becauſe the newly mentioned obſervations ſeem to argue the corpuſcles of air to be irreducible into water, whereas the aqueous particles may perhaps for a while be ſo vehemently agitated, as to preſs almoſt like ſprings upon other bodies; yet upon the ceaſing of the agitation, they quickly, by relapſing into water, diſcloſe themſelves to have been nothing elſe whilſt they counterfeited the air.

LASTLY, the experiment formerly made in our engine with a piece of match, ſeems to evince, that even thoſe light and ſubtile fumes (for the moſt part not aqueous neither) into which the fire itſelf ſhatters dry bodies, have no ſuch ſpring in them as the air, ſince they were unable to hinder or repreſs the expanſion of the air included in the bladder they ſurrounded.

Natural and Moral Hiſt. of the Indies, Lib. 3. c. 9.

I REMEMBER indeed, that the learned *Joſephus Acoſta*, in his hiſtory of the *Weſt Indies*, tells us, that he ſaw in thoſe parts ſome grates of iron ſo ruſted and conſumed by the air, that the metal being preſſed between the fingers, diſſolved (to uſe his words) to powder, as if it had been hay or parched ſtraw. And I remember too, that the accurate *Varenius* tells us, that in the iſlands commonly called *Azores*, the air (and wind) is ſo ſharp, that in a ſhort time it frets not only iron plates, but the very tiles upon the roofs of houſes, and reduceth them to duſt. And I have elſewhere mentioned ſome recent obſervations of this kind. But it may be ſaid, that the abovementioned authors aſcribe the recited effects chiefly to the winds, and that however the corroſion of the iron and the tiles may proceed not from the air itſelf, or any of its genuine parts, but from ſome ſaline corpuſcles diſperſed through the air, and driven by the winds againſt the bodies it is preſumed to fret. And that ſuch volatile ſalts may copiouſly aſcend into the air, and yet retain their nature, as doth the more fixt ſalt in the ſea-water, the ſublimations of ſal-armoniack may ſufficiently evince. Not to mention, that I have ſhewn ſome friends a ſecret kind of ſaline ſubſtance incomparably ſubtler than ſal-armoniack, which did not only eaſily enough aſcend itſelf, but carried up with it (and that in a very great proportion) the ſolid and ponderous body even of uncalcined gold in the form of ſubtile exhalations, which did afterwards faſten themſelves to the upper parts of the veſſels, and yet manifeſt themſelves to continue gold. We remember alſo, that to try whether water could be turned into air, we once took an æolipile, into which we had before conveyed ſome water, and placing it upon kindled coals when the heat forced out a vehement ſtream of aqueous vapours; we tied about the neck of it, that of a bladder, which we had before emptied of air; and finding the æolipile after a while to blow up the bladder, we carefully tied it again, that the included ſubſtance might not get away. Then ſlipping it off from the æolipile, we conveyed it into our receiver, to try whether or no that, which in part diſtended the bladder, would appear by its ſpring to be true air: whereby we found that upon the exſuction of the ambient air, the included ſubſtance expanded itſelf and the bladder to a very much greater bulk than it was of before. And for farther ſatisfaction, having again taken out the bladder, we ſuffered it to remain tied up till next morning, to try whether time, and the coldneſs of the night, would make the contained ſubſtance relapſe into water: but the next morning we found it little leſs tumid than before. I remember, I ſay, that I once made this experiment; but I might ſay in anſwer to it, that the chief reaſon of my mentioning it, is, to let your Lordſhip ſee, how requiſite it is to be circumſpect and conſiderate, when we are to make and to build upon nice experiments. For though I may ſeem to have uſed ſufficient caution, yet afterward conſidering with my ſelf that the æolipile I had imployed was a very large one, and that it required much more care than one that hath not tried it would imagine, to drive out all the air from a large æolipile, I eaſily ſuſpected that the diſtenſion of the bladder in our pneumatical

Geogr. General. Lib. 1. cap. 19.

veſſel, might proceed not from the watery ſteams that came out at the narrow mouth of the æolipile, and had very much wetted the bladder, but from the rarefied air which in that ſort of veſſels is wont for a good while together to come out with the rarefied water: and accordingly having reiterated the experiment, I found it very difficult (by reaſon of the ſhrinking of the bladders upon their being heated, and of other experiments) to make it ſo accurately as to deduce from it, that water may be rarefied into true air.

AGAINST the other four above-mentioned conſiderations, we cannot ſpend time to frame objections, but muſt forthwith proceed to the mention of thoſe things that ſeem to argue that air (at leaſt ſuch as produced our bubbles) may be generated of water and other bodies.

FIRST then, we have found by experience that a vapid air, or water rarefied into vapour, may at leaſt for a while emulate the elaſtical power of that which is generally acknowledged to be true air. For if you take a good æolipile, with a moderately ſtrong and ſlender neck, and filling it with water, lay it upon quick coals, you may, after a while, obſerve ſo great a preſſure by ſome of the parts contained in the æolipile upon others, that the water will ſometimes be thrown up into the air above three or four foot high; and if you then take the æolipile almoſt red-hot from off the fire, you may perceive that the water will, for a longer time than one would eaſily imagine, continue to be ſpouted out in a violent ſtream. And if there remains but little water in the æolipile when 'tis taken very hot from the fire, immerſing the neck of it into cold water, you will find, that after it begins to ſuck in ſome water, there will be made from time to time ſtore of large bubbles in that water wherein the neck was plunged. Which bubbles ſeem manifeſtly to proceed from hence, that for a while the heat in the æolipile continues ſtrong enough to rarefy part of the water that is ſucked in, and expel it in the form of vapours through the water incumbent on the pipe. If alſo when the æolipile is almoſt full of water, and therefore can contain but little air; you hold a coal or brand in that ſtream of vapours that iſſues out of the narrow mouth of it, you will find this vapid or rorid air (if I may ſo call it) to blow the fire very ſtrongly, and with a roaring noiſe. And that it be not ſaid that it is by the external air which the aqueous ſteams drive before them, and not by the ſteams themſelves, that the blaſt is made and the flame excited; it hath been obſerved, that by approaching the coal or brand almoſt to the mouth of the æolipile, the wind appeared more vehement, than if the body to be kindled were held ſome inches off.

BUT in regard the elaſtical power of the ſtream, iſſuing out of an æolipile, ſeems manifeſtly due to the heat that expands and agitates the aqueous particles whereof that ſtream conſiſts, and that ſuch rapid winds ſeem to be but water ſcattered into little parts and ſet a-moving; ſince we find, that holding a knife, or any ſolid, ſmooth, and cloſe body againſt the ſtream that iſſues out of the æolipile, the vapours condenſing upon it, will preſently cover it with water: it will be very pertinent to ſubjoin a notable experiment that I remember I have met with, in the deſcription given us by the induſtrious *Kircher*, of ſeveral muſical engines. And (though it may ſeem ſomewhat prolix) we will recite what he delivers in his own words, which are theſe.

Cum eodem tempore quo hæc ſcripſi, ſummi Pont. Innocentii X^mi *mandato organi hydraulici in horto Quirinali conſtituendi cura mihi commendata eſſet, Æoliam cameram inſigni ſanè ſucceſſu conſtrui juſſimus, eâ quæ ſequitur ratione.* Kirch. Art. Mag. Con. & Diſſon. *lib.* 9. *p.* 309.

Erat longitudo ſive altitudo cameræ AH 5 *pedum, latitudine* 3 *ferè ex lateribus conſtructa; in medio duo tenebat diaphragmata* CD *&* EF *in modum cribri pluribus foraminibus pertuſi. Paulo infra canalis* G *aquam advehens inſerebatur in* H *eidem epiſtomium parabat exitum. Aqua itaque per canalem* G *maximo impetu ruens vehementiſſimum ventum mox intus excitabat; qui ventus nimiâ humiditate imbutus, ut purior exiret ſicciórque, diaphragmata illa in cribri modum pertuſa, ordinata ſunt. Intra hæc enim aquæ vehemens agitatio rupta fractáque aërem puriorem per* A *canalem ſubtiliorémque emittebat: verum cum poſtea inventum ſit aërem plus æquo humidum interioribus organi meatibus maximum detrimentum inferre: hinc, ut aër aquoſus ſicciſſimam conſiſtentiam acquireret, ordinavimus canalem plumbeum* QR *in helicem contortum vaſi* S *aliquantulum capaciori in modum urnæ efformato, inſertum. Intra urnam enim plumbeam & canalem tortuoſum illiſus aër humidus, ita ab omni aquoſitate defæcabatur, ut ex furno in organum derivatus dici potuerit. Urna* S *canalis tortuoſi* QR *ultimum orificium* Z *inſeritur anemothecæ organi. Et hunc modum organis hydraulicis omnium aptiſſimum reperi.* See the fifteenth figure.

Debet autem camera illa ſituari in loco quantum fieri poteſt ſicciori, ita ut longo canali aqua intra eam derivetur, ne locus humiditate ſuâ organis officiat.

THUS far the ingenious *Kircherus*, whom I the rather cite, becauſe although I have been informed of divers ventiducts (as they call them) by very knowing travellers that have obſerved them; yet this relation of our author being very punctual, and delivered upon his own particular experience, hath, I confeſs, made me wiſh I had had the good fortune when I was at *Rome*, to take notice of theſe organs; or that I had now the opportunity of examining of ſuch an experiment. For, if upon a ſtrict enquiry I ſhould find that the breath that blows the organs doth not really upon the ceaſing of its unuſual agitation by little and little relapſe into water, I ſhould ſtrongly ſuſpect that it is poſſible for water to be eaſily turned into air. I remember indeed, that we have formerly taught, that there lurks an interſperſed air in the pores of ordinary water, which may poſſibly be ſtruck out by the breaking of the water in its fall into the Æolian chamber, (as he calls it.) But in regard the ſcheme ſeems to repreſent that chamber as cloſely ſhut, and thereby forbids us to ſuppoſe that any air is carried into it, but what is latitant in the water, it will ſcarce ſeem probable (to him who remembers how ſmall a proportion of air

air that appeared to be, when its rarefication ceaſed, which was concealed in the water we freed from bubbles in our receiver) that ſo little air as is commonly diſperſed through water, ſhould be able, in ſo little water as was requiſite for ſo ſmall a room, to make ſo vehement a wind as our author here tells us of. I have ſometime therefore ſuſpected, that in this caſe the wind may be produced by ſmall particles of the water it ſelf, forcibly expelled out of the chamber into the organs. And to the objection, to which I foreſaw this gueſs to be liable, namely, that, no heat intervening, there appeared nothing that ſhould raiſe the water into exhalations, and give them an impulſe; I thought it might be ſaid, that motion alone, if vehement enough, may, without ſenſible heat, ſuffice to break water into very minute parts, and make them aſcend upwards, if they can no where elſe more eaſily continue their agitation. For I remember that travelling betwixt *Lyons* and *Geneva*, I ſaw, not very far out of the way, a place where the river of *Rhone*, coming ſuddenly to be ſtraitened betwixt two rocks, ſo near each other, that a man may, (if my memory fail me not) ſtand aſtride upon both at once; that rapid ſtream daſhing with great impetuoſity againſt its rocky boundaries, doth break part of its water into ſuch minute corpuſcles, and put them into ſuch a motion, that paſſengers obſerve at a good diſtance off, as it were a miſt ariſing from that place, and aſcending a good way up into the air. Such, I ſay, was my ſuſpicion touching the wind we have been conſidering; but it ſeems ſomething odd that aqueous vapors ſhould, like a dry wind, paſs through ſo long and tortuous a pipe of lead, as that deſcribed by our author, ſince we ſee in the heads of ſtills, and the necks of æolipiles, how quickly ſuch vapours are even by a very little cold recondenſed into water. But to this alſo ſomething may be ſpeciouſly replied; wherefore contenting my ſelf to have mentioned our author's experiment as a plauſible, though not demonſtrative proof, that water may be tranſmuted into air, we will paſs on to mention in the third place another experiment, which we tried in order to the ſame enquiry.

WE took a clear glaſs bubble (capable of containing by gueſs about three ounces of water) with a neck ſomewhat long and wide, of a cylindrical form; this we filled with oil of vitriol and fair water, of each almoſt a like quantity, and caſting in half a dozen ſmall iron nails, we ſtopt the mouth of the glaſs (which was top full of liquor) with a flat piece of diapalma provided for the purpoſe, that, accommodating itſelf to the ſurface of the water, the air might be exquiſitely excluded: and ſpeedily inverting the phial, we put the neck of it into a ſmall wide-mouthed glaſs, that ſtood ready, with more of the ſame liquor in it, to receive it. As ſoon as the neck had reached the bottom of the liquor it was dipped into, there appeared at the upper part (which was before the bottom) of the phial a bubble, of about the bigneſs of a pea, which ſeemed rather to conſiſt of ſmall and recent bubbles, produced by the action of the diſſolving liquor upon the iron, than any parcel of the external air that might be ſuſpected to have got in upon the inverſion of the glaſs, eſpecially ſince we gave time to thoſe little particles of air which were carried down with the nails into the liquor to fly up again. But whence this firſt bubble was produced, is not ſo material to our experiment, in regard it was ſo ſmall: for ſoon after we perceived the bubbles produced by the action of the menſtruum upon the metal, aſcending copiouſly to the bubble named, and breaking into it, did ſoon exceedingly increaſe it, and by degreſs depreſs the water lower and lower, till at length the ſubſtance contained in theſe bubbles poſſeſſed the whole cavity of the glaſs phial, and almoſt of its neck too, reaching much lower in the neck than the ſurface of the ambient liquor, wherewith the open-mouthed glaſs was by this means almoſt repleniſhed. And becauſe it might be ſuſpected that the depreſſion of the liquor might proceed from the agitation whereinto the exhaling and impriſoned ſteams were put, by that heat which is wont to reſult from that action of corroſive ſalts upon metals, we ſuffered both the phial and the open-mouthed glaſs to remain as they were, in a window, for three or four days and nights together; but looking upon them ſeveral times during that while, as well as at the expiration of it, the whole cavity of the glaſs bubble, and moſt of its neck, ſeemed to be poſſeſſed by air, ſince by its ſpring it was able for ſo long to hinder the expelled and ambient liquor from regaining its former place. And it was remarkable, that juſt before we took the glaſs bubble out of the other glaſs, upon the application of a warm hand to the convex part of the bubble; the impriſoned ſubſtance readily dilated it ſelf like air, and broke through the liquor in divers bubbles ſucceeding one another.

HAVING alſo another time tried the like experiment with a ſmall phial, and with nails diſſolved in aqua fortis, we found nothing incongruous to what we have now delivered. And this circumſtance we obſerved, that the newly generated ſteams did not only poſſeſs almoſt all the whole cavity of the glaſs, but divers times without the aſſiſtance of the heat of my hand, broke away in large bubbles through the ambient liquor into the open air: ſo that theſe experiments with corroſive liquors, ſeemed manifeſtly enough to prove, though not that air may be generated out of the water, yet that in general air may be generated anew.

LASTLY, to the foregoing arguments from experience we might eaſily ſubjoin the authority of *Ariſtotle*, and of (his followers) the ſchools, who are known to have taught, that air and water being ſymbolizing elements, (in the quality of moiſture) are eaſily tranſmutable into one another. But we ſhall rather to the foregoing argument add this, drawn from reaſon, that if, as *Leucippus*, *Democritus*, *Epicurus* and others, followed by divers modern Naturaliſts, have taught, that the difference of bodies proceeds but from the various magnitudes, figures, motions, and textures of the ſmall parts they conſiſt of, (all the qualities that make them differ, being deducible from thence) there appears no

reaſon

reaſon why the minute parts of water, and other bodies, may not be ſo agitated or connected as to deſerve the name of air. For if we allow the Carteſian hypotheſis, according to which, as we noted at the beginning of this letter, the air may conſiſt of any terrene or aqueous corpuſcles, provided they be kept ſwimming in the interfluent celeſtial matter; it is obvious that air may be as often generated as terreſtrial particles, minute enough to be carried up and down, by the celeſtial matter, aſcend into the atmoſphere. And if we will have the air to be a congeries of little ſlender ſprings, it ſeems not impoſſible, though it be difficult, that the ſmall parts of divers bodies may by a lucky concourſe of cauſes be ſo connected, as to conſtitute ſuch little ſprings, ſince (as we note in another treatiſe) water in the plants it nouriſheth is uſually contrived into ſpringy bodies, and even the bare altered poſition and connection of the parts of a body may ſuffice to give it a ſpring that it had not before, as may be ſeen in a thin and flexible plate of ſilver; unto which, by ſome ſtrokes of a hammer, you may give a ſpring, and by only heating it red-hot, you may make it again flexible as before.

THESE, my Lord, are ſome of the conſiderations at preſent occurring to my thoughts, by which it may be made probable, that air may be generated a-new. And though it be not impoſſible to propoſe objections againſt theſe, as well as againſt what hath been repreſented in favour of the contrary doctrine; yet having already almoſt tired my ſelf, and I fear more than almoſt tired your Lordſhip with ſo troubleſome an inquiry after the nature of bubbles, I ſhall willingly leave your Lordſhip to judge of the arguments alledged on either ſide; and I ſhould ſcarce have ventured to entertain you ſo long concerning ſuch empty things as the bubbles, which have occaſioned all this diſcourſe, but that I am willing to invite you to take notice with me of the obſcurity of things, or the dimneſs of our created intellects, (which yet of late too many ſo far peſume upon, as either to deny or cenſure the Almighty and Omniſcient Creator himſelf) and to learn hence this leſſon, that there are very many things in nature that we diſdainfully overlook as obvious or deſpicable, each of which would exerciſe our underſtandings, if not poſe them too, if we would but attentively enough conſider it, and not ſuperficially contemplate, but attempt ſatisfactorily to explicate the nature of it.

EXPERIMENT XXIII.

SINCE the writing of the twenty-firſt and twenty-ſecond experiments (and notwithſtanding all that hath been on their occaſion delivered concerning bubbles) we made ſome farther trials in proſecution of the ſame inquiry whereto they were deſigned.

WE choſe then, amongſt thoſe glaſſes which chymiſts are wont to call philoſophical eggs, one that containing about nine ounces of water, had a neck of half an inch in diameter at the top, and as we gueſſed, almoſt an inch at the bottom; which breadth we pitched upon for a reaſon that will by and by appear: then filling it up with common water to the height of about a foot and an half, ſo that the upper part remained empty, we ſhut it into the receiver, and watched what would follow upon pumping, which proved that a great part of the air being drawn out, the bubbles began to diſcover themſelves at the bottom and ſides of the glaſs; and increaſing, as the air was more and more drawn away, they did from time to time aſcend copiouſly enough to the top of the water, and there quickly break; but by reaſon that the wideneſs of the glaſs allowed them free paſſage through the water, they did not appear as in the former experiments to make it ſwell: the water ſcarce ever riſing at all above the mark affixed to its upper ſurface, when it was put in; and upon the return permitted to the outward air, and conſequently the ſhrinking in of the remaining bubbles, the water ſeemed to have loſt of its firſt extent, by the avolation of the formerly interſperſed air.

BEING willing likewiſe to try whether diſtilled water were, by having been divided into minute parts, and then re-united, more or leſs diſpoſed to expand itſelf than water not diſtilled; we took out of our laboratory ſome carefully diſtilled rain-water, and put about two ounces of it into a round glaſs-bubble, with a very ſmall neck (not exceeding the ſixth part of an inch in diameter) which we filled half way to the top, and then conveyed it into the receiver; the iſſue was, that though we drew out more air than ordinary, yet there appeared not the leaſt intumeſcence of the water, nor any aſcending bubbles.

BUT ſuſpecting that either the ſmall quantity of the water or the figure of the veſſel might have an intereſt in this odd phænomenon, we took the lately mentioned philoſophical egg, and another not much differing from it; the former we filled up with diſtilled rain-water to the old mark, and into the latter we put a long cylinder or rod of ſolid glaſs to ſtraiten the cavity of the neck by almoſt filling it up; and then pouring ſome diſtilled water into that alſo, till it reached within ſome fingers breadth of the top, the eggs were let down into the receiver. In this experiment the air was ſo far drawn forth, before there appeared any bubble in either of the glaſſes, that the diſparity betwixt this and common water was manifeſt enough. But at length, when the air was almoſt quite pumped out, the bubbles began to diſcloſe themſelves, and to increaſe as the preſſure of the air in the receiver decreaſed. But whereas in the firſt mentioned philoſophical egg the bubbles were very ſmall, and never able to ſwell the water, that we took notice of, at all above the mark; in the other, whoſe neck, as we lately ſaid, was ſtraitned, and their paſſage obſtructed, great numbers of them, and bigger, faſtened themſelves to the lower end of the glaſs-rammer (if we may ſo call it) and gathered in ſuch numbers between that and the ſides of the neck, that the water ſwelled

about a finger's breadth above the mark, though upon the admitting of the external air it relapſed to the former mark, or rather fell ſomewhat below it. And although thereupon in the firſt named veſſel all the bubbles preſently diſappeared, yet in the other we obſerved, that divers remained faſtened to the lower part of the glaſs-rammer, and continued there, ſomewhat to our wonder, for above an hour after, but contracted in their dimenſions.

MOREOVER, having ſuffered the glaſſes to remain above twenty-four hours in the receiver, we afterwards repeated the experiment to try what change the exſuction of the external air would produce in the water, after the internal and latitant air had (as is above recited) in great meaſure got away in bubbles; and whether or no the water would, by ſtanding, re-admit any new particles of air in the room of thoſe that had forſaken it. But though we exhauſted the receiver very diligently, yet we ſcarce ſaw a bubble in either of the glaſſes; notwithſtanding which, we perceived the water to riſe about the breadth of a barley-corn, or more, in the neck of that glaſs wherein the ſolid cylinder had been put; the liquor in the other glaſs not ſenſibly ſwelling.

AND laſtly, upon the letting in of the air, the water in the ſtraitened neck ſoon ſubſided to the mark above which it had ſwollen; which whether it ought to be aſcribed to the ſame ſmall expanſion of the parts of the water it ſelf, or to the rarefaction of ſome yet latitant air broken into ſuch ſmall particles, as to eſcape our obſervation, ſeems not eaſily determinable, without ſuch farther trials, as would perhaps prove tedious to be recited as well as to be made; though I was content to ſet down thoſe already mentioned, that it might appear, how requiſite it is in nice experiments to conſider variety of circumſtances.

EXPERIMENT XXIV.

AFTER having thus diſcovered what operation the exſuction of the ambient air had upon water, we thought good to try alſo what changes would happen in other liquors upon the like taking off the preſſure of the external air. We took then a glaſs egg, ſomewhat bigger than a turkey's egg, which had a long neck or ſtem of about a third part of an inch in diameter; and filling it up with ſallad-oil, until it reached above half way to the top of the neck, we incloſed it in the receiver, together with common water in a reſembling veſſel, that we might the better compare together the operation of the exſuction of the air upon thoſe two liquors. The pump being ſet on work, there began to appear bubbles in the oil much ſooner than in the water, and afterwards they alſo aſcended much more copiouſly in the former liquor than in the latter: nay, and when by having quite tired the pumper, and almoſt our own patience, we gave over, the bubbles roſe almoſt (if not altogether) in as great numbers as ever, inſomuch that none of the various liquors we tried either before or ſince, ſeemed to abound more with aërial particles than did this oil. In which it was farther remarkable, that between the time it was ſet into the receiver, and that, at which we could get ready to pump, it ſubſided notably (by gueſs about half an inch) below the mark it reached before it was put in.

AFTER this expreſſed oil, we made trial of a diſtilled one; and for that purpoſe made choice of the common oil or ſpirit (for in the ſhops where it is ſold, the ſame liquor is promiſcuouſly called by either name) of turpentine, becauſe it was only of that chymical oil we had a ſufficient quantity: which, being put into a ſmall glaſs-bubble with a ſlender neck, ſo as to fill it about two inches from the top, did, upon the evacuating of the receiver, preſent us with great ſtore of bubbles, moſt of which riſing from the bottom, expanded themſelves exceedingly in their aſcent, and made the liquor in the neck to ſwell ſo much by degrees, that at length it divers times ran over at the top: by which means we were hindered from being able to diſcern upon the letting in of the air, how much the ſubſidence of the oil below the firſt mark was due to the receſs of the bubbles.

HAVING likewiſe a mind to try, whether as ſtrong a ſolution of ſalt of tartar in fair water as could be made (we having then no oil of tartar *per deliquium* at hand) though it be accounted, quickſilver excepted, the heavieſt of liquors, would afford us any bubbles; we put in a glaſs-egg full of it at the ſame time with other liquors, and found, that they did long yield ſtore of bubbles before any diſcovered themſelves in the liquor of tartar; and having purſued the experiment, it appeared, that of all the liquors we made trial of, this afforded the feweſt and ſmalleſt bubbles.

SPIRIT of vinegar being tried after the ſame manner, exhibited a moderate number of bubbles, but ſcarce any thing elſe worth the mentioning.

NOR could we in red wine, tried in a glaſs-egg, take notice of any thing very obſervable. For though upon the exſuction of the air the bubbles aſcended in this liquor, as it were in ſhoals, and ſhifted places among themſelves in their aſcent; yet the intumeſcence of the whole bulk of the liquor was ſcarce at all ſenſible, the bubbles moſt commonly breaking very ſoon after their arrival at the top, where during their ſtay they compoſed a kind of ſhallow froth, which alone appeared higher in the neck of the glaſs than was the wine when it was let down. Neither yet did milk, conveyed into our pneumatical veſſel, preſent us with any thing memorable, ſave that (as it ſeemed by reaſon of ſome unctuouſneſs of the liquor) the bubbles not eaſily breaking at the top, and thruſting up one another, made the intumeſcence appear much greater than that of common water.

WE likewiſe conveyed hen's eggs into the receiver, but after the exſuction of the air, took them out whole again. That which invited us to put them in, was, that (as perhaps we mention in other papers) we had among other experiments of cold, made eggs burſt, by freezing them within doors with ſnow

and ſalt; the ice, into which the aqueous parts of the egg were turned by the cold, ſo diſtending (probably by reaſon of the numerous bubbles wont to be obſervable in ice) the outward parts of the egg, that it uſually cracked the ſhell, though the inner membrane, that involved the ſeveral liquors of the egg, becauſe it would ſtretch and yield, remained unbroken. And hereupon we imagined, that in our engine it might appear, whether or no there were any conſiderable ſpring, either in any of the liquors, or in any other more ſpiritous ſubſtance included in the egg.

WE took alſo ſome ſpirit of urine, careleſly enough deflegmed, and put it into the ſame glaſs (firſt carefully ſcoured and cleanſed) wherein we had put the oil olive above mentioned: we took alſo another glaſs, differing from a glaſs egg, only in that its bottom was flat, and filled it up to about $\frac{2}{3}$ of the neck (which was wider than that of the egg) with rectified ſpirit of wine.

WE took alſo another glaſs-egg; and having filled it with common water till it reached to the middle of the neck, we poured to it of the ſame ſpirit of wine, till it reached about an inch higher.

THESE three glaſſes having marks ſet on them, over againſt the edges of the contained liquors, were put into the receiver; and that beginning to be evacuated, the bubbles in all the three liquors began to appear. The mixture of the ſpirit of wine and water diſcloſed a great ſtore of bubbles, eſpecially towards the top; but ſcarce afforded us any thing worth the remembring. The ſpirit of urine appeared to ſwell near an inch and an half above the mark; and beſides that, ſent forth ſtore of bubbles, which made a kind of froth at the upper part of it. And above that ſpume, there appeared eight or ten great bubbles one above another, in a very decent order, each of them conſtituting, as it were, a cylinder of about half an inch high, and as broad as the internal cavity of the neck: ſo that all the upper part of the neck (for theſe bubbles reached to the top) ſeemed to be divided into almoſt equal parts by certain diaphragms, conſiſting of the coats of the bubbles, whoſe edges appeared like ſo many rings ſuſpended one above another.

IN the ſpirit of wine there did ariſe a great multitude of bubbles, even till wearineſs did make us give over the experiment. And in theſe bubbles two or three things were remarkable; as firſt, that they aſcended with a very notable celerity; next, that being arrived at the top, they made no ſtay there: and yet, notwithſtanding the great thinneſs and ſpiritouſneſs of the liquor, did, before they broke, lift up the upper ſurface of it, and for a moment or two form thereof a thin film or ſkin, which appeared protuberant above the reſt of the ſuperficies like a ſmall hemiſphere. Thirdly, that they aſcended ſtreight up; whereas thoſe produced at the lower part of the veſſel, containing the mixture of the water and ſpirit of wine, aſcended with a wavering or wriggling motion, whereby they deſcribed an indented line. Laſtly, it was obſervable in the ſpirit of wine (and we took notice of the like in the oil of turpentine lately mentioned) that not only the bubbles ſeemed to riſe from certain determinate places at the bottom of the glaſs, but that in their aſcenſion they kept an almoſt equal diſtance from each other, and followed one another in a certain order, whereby they ſeemed part of ſmall bracelets, conſiſting of equally little incontiguous beads, the lower end of each bracelet being, as it were, faſtened to a certain point at the bottom of the glaſs.

THE air being ſparingly let into the receiver, the great bubbles formerly mentioned as incumbent upon one another, in that glaſs that contained the ſpirit of urine, were by orderly degrees leſſened, till at length they wholly ſubſided. Notwithſtanding the receſs of ſo many bubbles, as broke on the top of the ſpirit of urine, during all the time of the experiment; yet it ſcarcely appeared at all to be ſunk below the mark: nor did the mixture of ſpirit of wine and water conſiderably ſubſide. But that is nothing to what we obſerved in the ſpirit of wine; for not only it conſpicuouſly expanded itſelf in the neck of the veſſel that contained it, notwithſtanding the largeneſs of it, and that the bubbles were wont to break at the top of it almoſt as ſoon as they arrived there; but upon the re-admiſſion of the external air, the ſpirit of wine retained its newly acquired expanſion. And though we let it alone for near an hour together, in expectation that it might ſubſide; yet when we took it out, we found it ſtill ſwelled between a quarter and half an inch above the mark; and although it was not eaſily imaginable, how this phænomenon could proceed from any miſtake in trying the experiment, yet the ſtrangeneſs of it invited me to repeat it with freſh ſpirit of wine. Which, ſwelling in the neck as formerly, I left all night in the receiver, allowing free acceſs to the external air at the ſtop-cock; and the next day found it ſtill expanded as before, ſave that it ſeemed a little lower: which decrement perhaps proceeded from the avolation of ſome of the fugitive parts of ſo volatile a liquor. And for better ſatisfaction having taken out the glaſs, and conſidered it in the open air, and at a window, I could not find, that there were any remaining bubbles, that could occaſion the perſevering and admired expanſion.

EXPERIMENT XXV.

BEING deſirous to diſcover what difference there might be, as to gravity and levity, between air expanded under water, and itſelf before ſuch expanſion; we took two very ſmall phials, ſuch as chymical eſſences (as they call them) are wont to be kept in, and of the ſize and ſhape expreſſed by the eighth figure. Into one of theſe we put ſo much of a certain ponderous mercurial mixture (happening to be then at hand) that the mouth being ſtopt with a little ſoft wax, the glaſs would juſt ſink in water and no more. This we let fall to the bottom of a wide-mouthed cryſtal jar, filled with about half a pint of common water, and into the ſame veſſel we ſunk the other eſſence-glaſs unſtopped,

with

with as much water in it as was more than ſufficient to make it ſubſide. Both theſe ſunk with their mouths downwards, the former being about three quarters full of air, the latter containing in it a bubble of air, that was gueſſed to be of the bigneſs of half a pea: this done, the wide-mouthed glaſs was let down into the receiver, and the way of employing the engine was carefully made uſe of.

THE ſucceſs was, that having drawn out a pretty quantity of air, the bubbles began to diſcloſe themſelves in the water, as in the former experiments; and though for a good while after the bubbles aſcended in ſwarms from the lower parts of the water, and haſtily broke at the top; yet we proſecuted the experiment ſo long without ſeeing any effect wrought upon the eſſence-bottles, that we began to deſpair of ſeeing of them riſe. But continuing to ply the pump, that little glaſs, whoſe mouth was opened, came to the top of the water, being, as it were, buoyed up thither by a great number of bubbles, that had faſtened themſelves to the ſides of it; ſwimming thus with the mouth downward, we could eaſily perceive, that the internal air above mentioned had much dilated itſelf, and thereby ſeemed to have contributed to the emerging of the glaſs, which remained floating, notwithſtanding the breaking and vaniſhing of moſt of the contiguous bubbles. Being hereby incouraged to perſiſt in pumping, we obſerved, with ſome pleaſure, that at each time we turned the key, the air in the little glaſs did manifeſtly expand itſelf and thruſt out the water, generally retaining a very protuberant ſurface, where it was contiguous to the remaining water. And when after divers exſuctions of the air in the receiver, that in the phial ſo dilated itſelf as to expel almoſt all the water, it turned up its mouth towards the ſurface of the water in the jar, and there delivered a large bubble, and then relapſed into its former floating poſture. And this experiment taught us, among other things, that it was a work of more time and labour than we imagined, to exhauſt our engine as much as it may be exhauſted: for, although before the emerging of the ſmall phial, we did (as hath been touched already) think we had very conſiderably emptied the receiver, becauſe there ſeemed to come out but very little or almoſt no ſenſible air at each exſuction into, and out of the cylinder; yet afterwards, at each drawing down the ſucker, the air included in the phial did manifeſtly dilate itſelf ſo long, that it did no leſs than nine times turn its mouth upwards, and diſcharge a bubble by conjecture about the bigneſs of a pea, after the manner newly recited. But as for that phial, which had the weight in it, it roſe not at all. So that being not able by quick pumping to gain another bubble from the air in the ſwimming glaſs, which proceeded from ſome ſmall leak in the veſſel, though it held in this experiment more ſtanch than was uſual, we thought fit to let in leiſurely the air from without, upon whoſe admiſſion that within the phial ſhrinking into a very narrow compaſs, the glaſs did, as we expected, fall down to the bottom of the jar.

BUT being deſirous, before we proceed to any new experiment, to try once more whether the little glaſs, that had the weight in it, might not alſo be raiſed; after we had ſuffered the engine to remain cloſed as it was, for five or ſix hours, the pump was again plied with ſo much obſtinacy, that not only about the upper part of the jar there appeared a good number of bubbles (but very much ſmaller than thoſe we ſaw the firſt time) but afterwards, there came from the bottom of the jar bubbles about the bigneſs of ſmall peas; which, the pump being ſtill kept going, followed one another to the number of forty, coming from the ſtopt phial; whoſe mouth, it ſeems, had not been ſhut ſo ſtrongly and cloſely, but that the included air, dilating itſelf by its own ſpring, made itſelf ſome little paſſage betwixt the wax and the glaſs, and got away in theſe bubbles: after which, the unſtopt glaſs began to float again, the air ſhut up in it being manifeſtly ſo dilated as to expel a good part of the water, but not ſo much as to break quite thorough. And at length, when our expectation of it was almoſt tired out, the heavier of the two phials began to come aloft, and immediately to ſubſide again; which appeared to be occaſioned by the air within it, whoſe bulk and ſpring being weakened by the receſs of the forty bubbles before mentioned, it was no longer able, as formerly, to break forcibly through the incumbent water; but forming a bubble at the mouth of the glaſs, buoyed it up towards the top, and there getting away, left it to ſink again, till the preſſure of the air in the receiver being farther taken off, the air in the phial was permitted to expand itſelf farther, and to create another bubble, by which it was again for a while carried up. And it was remarkable, that though after having emptied the receiver as far as well we could, we ceaſed from pumping, yet the veſſel continuing more ſtanch than it was wont, this aſcent and fall of the phial was repeated to the ninth time; the included air, by reaſon of the ſmallneſs of the vent at which it muſt paſs out, being not able to get away otherwiſe than by little and little; and conſequently, in divers ſuch parcels as were able to conſtitute bubbles, each of them big enough to raiſe the phial, and keep it aloft until the avolation of that bubble. Whereby it may appear, that the grand rule in Hydroſtaticks, that a body will ſwim in the water, in caſe it be lighter than as much of the water as equals it in bulk, will hold likewiſe, when the preſſure of the atmoſphere is in very great meaſure, if not when it is totally taken off from the liquor and the body: though it were worth inquiring, what it is, that ſo plentifully concurs to fill the bubbles made in our experiment by the ſo much expanded air. For to ſay with the old Peripatetick ſchools, that the air in rarefaction may acquire a new extent, without the admiſſion of any new ſubſtance, would be an account of the phænomenon very much out of date, and which, I ſuppoſe, our modern naturaliſts would neither give nor acquieſce in.

I KNOW not whether it may be requiſite to add, that in this experiment, as in the former, the outward air, being let in, did ſoon precipitate

pitate the floating phial. But I think it will not be amiſs to note, that (congruouſly to what hath been above recorded of the vaſt expanſion of the air) the water, which in the heavier phial ſucceeded in the room of thoſe forty odd, if not fifty great bubbles of air, which at ſeveral times got out of it, amounted but to a very inconſiderable bigneſs.

EXPERIMENT XXVI.

IT having been obſerved by thoſe, that have conſidered what belongs to pendulums (a ſpeculation, that may, in my poor judgment, be highly uſeful to the Naturaliſts) that their vibrations are more ſlowly made, and that their motion laſts leſs in a thicker, than in a thinner medium; we thought it not amiſs to try, if a pendulum would ſwing faſter, or continue ſwinging longer in our receiver, in caſe of exſuction of the air, than otherwiſe. Wherefore we took a couple of round and poliſhed pendulums of iron or ſteel, of equal bigneſs, as near as we could get the artificer to make them; and weighing each of them twenty drachms, wanting as many grains: one of theſe we ſuſpended in the cavity of the receiver by a very ſlender ſilken ſtring, of about ſeven inches and a half in length, from the cover of the receiver to which it is faſtened. Then (by inclining the engine) we made the pendulum ſwing to and fro in it, and deſcribe as long arches, as in the capacity of ſo brittle a veſſel we thought ſafe and convenient. And one of the aſſiſtants telling the recurſions of the other pendulum hanging in the free air, by a ſtring of about the ſame length, we ſhortened and lengthened this other pendulum, till it appeared to keep the ſame pace in its vibrations with that ſhut up in the receiver. Then having carefully drawn away the air, we did again ſet the pendulum, in the receiver a vibrating; and giving the other pendulum ſuch a motion as made it deſcribe an arch, according to one's gueſs, equal to that of the included pendulum, we reckoned, one of us, the recurſions of that pendulum, which was ſwinging within the receiver; and another of us that, which was moving in (that which one would think a much more reſiſting medium) the air. But once, one of us reckoned near two and twenty recurſions of the included pendulum, whilſt the other reckoned but twenty of the pendulum that vibrated without. And another time alſo, the former of theſe pendula was reckoned to have made one and twenty recurſions, wherein the other made but twenty: yet this experiment ſeemed to teach us little, ſave that the difference betwixt the motion of ſuch a pendulum in the common air, and in one exceedingly rareſied, is ſcarce ſenſible in veſſels no bigger than our receiver; eſpecially, ſince though during this experiment it held very well, yet we could not ſuppoſe it to be altogether devoid of air. We obſerved alſo, that when the receiver was full of air, the included pendulum continued its recurſions about fifteen minutes (or a quarter of an hour) before it left off ſwinging; and that after the exſuction of the air, the vibration of the ſame pendulum (being freſh put into motion) appeared not (by a minute watch) to laſt ſenſibly longer. So that the event of this experiment being other than we expected, ſcarce afforded us any other ſatisfaction, than that of our not having omitted to try it. And whether, in caſe the trial be made with a pendulum much leſs diſproportionate to the air than ſteel is, the event will much better anſwer expectation, experience may be conſulted.

EXPERIMENT XXVII.

THAT the air is the medium, whereby ſounds are conveyed to the ear, hath been for many ages, and is yet the common doctrine of the ſchools. But this received opinion hath been of late oppoſed by ſome philoſophers upon the account of an experiment made by the induſtrious *Kircher*, and other learned men; who have (as they aſſure us) obſerved, that if a bell, with a ſteel clapper, be ſo faſtened to the inſide of a tube, that upon the making the experiment *de vacuo* with that tube, the bell remained ſuſpended in the deſerted ſpace at the upper end of the tube: and if alſo a vigorous load-ſtone be applied on the outſide of the tube to the bell, it will attract the clapper, which upon the removal of the load-ſtone falling back, will ſtrike againſt the oppoſite ſide of the bell, and thereby produce a very audible ſound; whence divers have concluded, that it is not the air, but ſome more ſubtle body, that is the medium of ſounds. But becauſe we conceived, that, to invalidate ſuch a conſequence from this ingenious experiment, (though the moſt luciferous, that could well be made without ſome ſuch engine as ours) ſome things might be ſpeciouſly enough alledged; we thought fit to make a trial or two, in order to the diſcovery of what the air doth in conveying of ſounds, reſerving divers other experiments triable in our engine concerning ſounds, till we can obtain more leiſure to proſecute them. Conceiving it then the beſt way to make our trial with ſuch a noiſe, as might not be loud enough to make it difficult to diſcern ſlighter variations in it, but rather might be, both laſting, (that we might take notice by what degrees it decreaſed) and ſo ſmall, that it could not grow much weaker without becoming imperceptible; we took a watch, whoſe caſe we opened, that the contained air might have free egreſs into that of the receiver. And this watch was ſuſpended in the cavity of the veſſel only by a pack-thread, as the unlikelieſt thing to convey a ſound to the top of the receiver; and then cloſing up the veſſel with melted plaiſter, we liſtened near the ſides of it, and plainly enough heard the noiſe made by the ballance. Thoſe alſo of us, that watched for that circumſtance, obſerved, that the noiſe ſeemed to come directly in a ſtreight line from the watch unto the ear. And it was obſervable to this purpoſe, that we found a manifeſt diſparity of noiſe, by holding our ears near the ſides of the receiver, and near the cover of it: which difference ſeemed to proceed from that of the texture

of the glaſs, from the ſtructure of the cover (and the cement) through which the ſound was propagated from the watch to the ear. But let us proſecute our experiment. The pump after this being employed, it ſeemed, that from time to time the ſound grew fainter and fainter; ſo that when the receiver was emptied as much as it uſed to be for the foregoing experiments, neither we, nor ſome ſtrangers, that chanced to be then in the room, could, by applying our ears to the very ſides, hear any noiſe from within; though we could eaſily perceive, that by the moving of the hand, which marked the ſecond minutes, and by that of the balance, that the watch neither ſtood ſtill, nor remarkably varied from its wonted motion. And to ſatisfy our ſelves farther, that it was indeed the abſence of the air about the watch, that hindered us from hearing it, we let in the external air at the ſtop-cock; and then though we turned the key and ſtopt the valve, yet we could plainly hear the noiſe made by the balance, though we held our ears ſometimes at two foot diſtance from the outſide of the receiver; and this experiment being reiterated into another place, ſucceeded after the like manner. Which ſeems to prove, that whether or no the air be the only, it is at leaſt the principal medium of ſounds. And by the way it is very well worth noting, that in a veſſel ſo well cloſed as our receiver, ſo weak a pulſe as that of the balance of a watch ſhould propagate a motion to the ear in a phyſically ſtreight line, notwithſtanding the interpoſition of ſo cloſe a body as glaſs, eſpecially glaſs of ſuch thickneſs as that of our receiver; ſince by this it ſeems the air impriſoned in the glaſs muſt, by the motion of the balance, be made to beat againſt the concave part of the receiver, ſtrongly enough to make its convex part beat upon the contiguous air, and ſo propagate the motion to the liſtner's ears. I know this cannot but ſeem ſtrange to thoſe, who, with an eminent modern philoſopher, will not allow, that a ſound, made in the cavity of a room, or other place ſo cloſed, that there is no intercourſe betwixt the external and internal air, can be heard by thoſe without, unleſs the ſounding body do immediately ſtrike againſt ſome part of the incloſing body. But not having now time to handle controverſies, we ſhall only annex, that after the foregoing experiment, we took a bell of about two inches in diameter at the bottom, which was ſupported in the midſt of the cavity of the receiver by a bent ſtick, which by reaſon of its ſpring preſſed with its two ends againſt the oppoſite parts of the inſide of the veſſel: in which, when it was cloſed up, we obſerved, that the bell ſeemed to ſound more dead than it did when juſt before it ſounded in the open air. And yet, when afterwards we had (as formerly) emptied the receiver, we could not diſcern any conſiderable change (for ſome ſaid they obſerved a ſmall one) in the loudneſs of the ſound. Whereby it ſeemed, that though the air be the principal medium of ſound, yet either a more ſubtle matter may be alſo a medium of it, or elſe an ambient body, that contains but very few particles of air, in compariſon of thoſe it is eaſily capable of, is ſufficient for that purpoſe. And this, among other things, invited us to conſider, whether in the above-mentioned experiment made with the bell and the load-ſtone, there might not in the deſerted part of the tube remain air enough to produce a ſound; ſince the tubes for the experiment *de vacuo* (not to mention the uſual thinneſs of the glaſs) being ſeldom made greater than is requiſite, a little air might bear a not inconſiderable proportion to the deſerted ſpace: and that alſo, in the experiment *de vacuo*, as it is wont to be made, there is generally ſome little air, that gets in from without, or at leaſt ſtore of bubbles, that ariſe from the body of the quickſilver, or other liquor it ſelf, obſervations heedfully made have frequently informed us; and it may alſo appear, by what hath been formerly delivered concerning the Torricellian experiment.

ON the occaſion of this experiment concerning ſounds, we may add in this place, that when we tried the experiment formerly mentioned, of firing gun-powder with a piſtol in our evacuated receiver, the noiſe made by the ſtriking of the flint againſt the ſteel was exceeding languid, in compariſon of what it would have been in the open air. And on divers other occaſions it appeared, that the ſounds created within our exhauſted glaſs, if they were not loſt before they reached the ear, ſeemed at leaſt to arrive there very much weakened. We intended to try, whether or no the wire-ſtring of an inſtrument ſhut up into our receiver would, when the ambient air was ſucked out, at all tremble, if in another inſtrument held cloſe to it, but without the receiver, a ſtring tuned (as muſicians ſpeak, how properly I now examine not) to an uniſon with it, were briſkly touched, and ſet a vibrating. This, I ſay, we purpoſed to try, to ſee how the motion made in the air without would be propagated through the cavity of our evacuated receiver. But when the inſtrument, wherewith the trial was to be made, came to be imployed, it proved too big to go into the pneumatical veſſel: and we have not now the conveniency to have a fitter made.

WE thought likewiſe to convey into the receiver a long and ſlender pair of bellows, made after the faſhion of thoſe uſually employed to blow organs, and furniſhed with a ſmall muſical inſtead of an ordinary pipe. For we hoped, that by means of a ſtring faſtened to the upper part of the bellows, and to the moveable ſtopple, that makes a part of the cover of our receiver, we ſhould, by frequently turning round that ſtopple, and the annexed ſtring, after the manner already often recited, be able to lift up and diſtend the bellows; and by the help of a competent weight faſtened to the ſame upper part of the bellows, we ſhould likewiſe be able at pleaſure to compreſs them, and, by conſequence, try whether, that ſubtler matter than air (which, according to thoſe that deny a vacuum, muſt be ſuppoſed to fill the exhauſted receiver) would we able to produce a ſound in the muſical pipe; or in a pipe like that of ordinary bellows, to beget a wind capable to turn or ſet on moving ſome very light matter, either

ſhaped like the ſails of a wind-mill, or of ſome other convenient form, and expoſed to its orifice. This experiment, I ſay, we thought to make; but have not yet actually made it for want of an artificer to make us ſuch a pair of bellows as it requires.

WE had thoughts alſo of trying, whether or no, as ſounds made by the bodies in our receiver become much more languid than ordinary, by reaſon of the want of air; ſo they would grow ſtronger, in caſe there were an unuſual quantity of air crouded and ſhut up in the ſame veſſel. Which may be done (though not without ſome difficulty) by the help of the pump, provided the cover and ſtopple be ſo firmly faſtned (by binding and cement, or otherwiſe) to the glaſs and to each other, that there be no danger of the condenſed air's blowing of either of them away, or its breaking through the junctures. Theſe thoughts, my Lord, as I was ſaying, we entertained; but for want of leiſure, as, of as good receivers as ours, to ſubſtitute in its place, in caſe we ſhould break it before we learned the ſkill of condenſing the air in it, we durſt not put them in practice. Yet on this occaſion give me leave to advertiſe your Lordſhip once for all, that though for the reaſons newly intimated, we have only in the ſeventeenth experiment, taken notice, that by the help of our engine the air may be condenſed as well as rarefied; yet there are divers other of our experiments, whoſe phænomena it were worth while to try to vary, by means of the compreſſion of the air.

EXPERIMENT XXVIII.

WE taught, among divers other things, when we diſcourſed of our firſt experiment, that the air ſhut up in our receiver preſſeth as ſtrongly upon the bodies ſhut up with it, as if they were expoſed to the preſſure of the whole atmoſphere. That this was not inconſiderately propounded, we hope your Lordſhip hath gathered from divers of the things already recited: but yet perhaps it will not be amiſs to ſubjoin, by way of farther confirmation of the ſame truth, the following experiment; which would have accompanied the 20th, but the paper, wherein the one was written, chanced not to be at hand, when the other was ſent away.

WE conveyed into the receiver a new glaſs phial, capable of holding about 6 or 7 ounces of water, into which we had before put 2 or 3 ſpoonfuls of that liquor, and ſtopt it cloſe with a fit cork. The pneumatical veſſel being emptied, there appeared not any change in the incloſed water, the air impriſoned with it, not having the force to blow out the ſtopple. Which event, though it were no other than we expected, was differing from what we deſired. For we would gladly have ſeen, what change would have appeared in the water upon the bottles being ſuddenly unſtopped, in a place where the ambient body was ſo differing from our common air. Wherefore we did again put in the phial, but leſs ſtrongly cloſed than formerly, though as ſtrongly ſtopt as ſeemed requiſite on ordinary occaſions: but when the air was pumped out of the receiver, that within the phial did quickly, as we expected, find or make itſelf little paſſages to get out at: as we argued, from this, that whereas when the phial was put in the time before, the water remained all the while perfectly free from bubbles; at this time the bottom of the glaſs appeared all covered with them, and they, upon the egreſs of the excluded air into the receiver, did preſently flag and ſhrink up.

FROM theſe trials it ſeemed deducible enough, that whilſt the phial continued to be well ſtopped, the included water did, from the air ſhut up with it, ſuſtain a preſſure equal to that of the atmoſphere; ſince till the air could get out of the glaſs, there appeared no bubbles in the water, notwithſtanding the want of preſſure in the ambient body.

BUT to be ſure to reach the chief end of our experiment, we made uſe of this other expedient. We cauſed a convenient quantity of water to be put, and hermetically ſhut up into a glaſs egg, whoſe long neck (which was purpoſely made of an unequal thickneſs) was faſtened to one end of a ſtring, whoſe other end was tied to the cover of our receiver, after the manner elſewhere mentioned already. Then the egg being conveyed into the pneumatical veſſel, and that being evacuated, we did, by turning the braſs-ſtopple formerly deſcribed amongſt the parts of our engine, ſo ſhorten the ſtring as to break the glaſs; whereby liberty being given to the air impriſoned in the egg to paſs into the cavity of the receiver, the ſudden receſs of the air made the bubbles in a trice appear ſo numerous, and aſcend ſo ſwiftly in the water, that their motion looked like that of a violent ſhower of rain; ſave that the bubbles did not, like the drops of rain, tend downwards, but upwards. Which made me reſemble this phænomenon to what I have ſeen happen in the diſſolution of ſeed-pearl in ſome acid menſtruum; in which, if a good quantity of the little pearls be caſt whole, they will at firſt, if the menſtruum be ſharp enough, be carried in ſwarms from the bottom to the top of the liquor. We will add, that without ſealing up the glaſs, this experiment may be tried in one of our ſmalleſt receivers. For there the exſuction of the ambient air may be performed ſo nimbly, that immediately the bubbles lurking in the water are allowed to diſplay themſelves, and aſcend in throngs; inſomuch, as having in ſuch a receiver tried the experiment with wine (as a more ſpirituous liquor) inſtead of water, the red-wine appeared all covered with a copious, but vaniſhing white froth, almoſt as if a veſſel full of bottled drink had been unwarily opened.

EXPERIMENT XXIX.

IT may not a little conduce to the clearer explication of divers points in the doctrine of meteors, and perhaps of ſome other phyſiological difficulties, to diſcover what the air doth to the motion of thoſe ſteams or exhalations that aſcend into it; namely, whether they mount upwards by virtue of any ſuch poſitive levity (as ſome Peripateticks ſpeak) acquired together with

with their aërial nature, as enables them to pierce through part of the atmoſphere, and overcome its reſiſtance. Or elſe, whether theſe ſteams being once raiſed above the earth by their agitation, have their aſcent and ſuſtentation aloft, rather promoted than hindered by the air: as the inferior parts of that, being thicker and heavier than the ſuperior, the ſteams can more eaſily continue for a while their agitation upwards than downwards; and afterwards are by the ſame fluidity and thickneſs of the air carried to and fro in it, and kept from relapſing to the earth: as in the ſea-water the ſaline parts are kept from ſubſiding by thoſe aqueous ones, wherewith they are aſſociated.

WE hoped to illuſtrate this matter, by obſerving the motion of the ſmoke, proceeding from kindled or flaming bodies in our exhauſted receiver. But as we formerly noted, upon the exſuction of the air, the ſmoking of thoſe bodies preſently ceaſed. We had thoughts alſo of conveying into our pneumatical glaſs a hot iron, with ſome body eaſy to be diſſipated into ſmoke ſet upon it; but conſidered, that neither was that way free from inconveniencies; eſpecially this, that the hot body would make the impriſoned air circulate within the receiver, and conſequently make it queſtionable, whether the aſcent of the ſteams would not be due to the new and acquired motion of the air.

WHEREFORE I bethought my ſelf of another way to ſatisfy in ſome meaſure my curioſity, to wit, by means of a certain liquor, which I called to mind, that ſome years ago I had (for a deſign that belongs not to our preſent purpoſe) prepared; which, I ſuppoſe, I ſhewed your Lordſhip, and which had the luck to be taken notice of by divers very ingenious and famous men. For this liquor, though moſt of its ingredients be metals, and all of them ponderous enough, is yet of that nature, that whilſt the phial wherein it is kept is ſtopped (how ſlight a cover ſoever) both the liquor and the glaſs are tranſparent; and ſo is that upper half of the glaſs, to which the liquor reacheth not: but as ſoon as ever the ſtopple is taken out, and full acceſs is given to the external air, both the inward part of the cork, and the liquor it ſelf, do preſently ſend upwards, and ſcatter abroad a fume as thick and white, as if there were a quantity of alabaſter-duſt thrown up into the air. And this ſmoking of the liquor laſts till my unwillingneſs to waſte it invites me to ſtop it again; and then the aſcenſion of the fumes ſuddenly ceaſeth, till the phial be again unſtopped.

THIS fuming liquor then, I thought, would much conduce to the diſcovery I deſired to make, ſince it ſaved me the need of conveying any hot body with it into the receiver, and would not darken it with fumes before the time. Wherefore having tied to the phial a great weight of lead, to keep it from being lifted up by the drawing out of the cork; and having tied to the ſtopple one end of a ſtring, of which the other end was made faſt to the cover of the pneumatical glaſs, the liquor was carefully cloſed up after the wonted manner: then the air being diligently pumped out, the phial was unſtopped in the emptied receiver. And though immediately, upon the drawing out of the cork, there appeared to be as it were thrown up ſome white fumes, which ſeemed to proceed from the air before impriſoned in the phial, and diffuſing it ſelf ſuddenly into the capacity of the receiver; yet we afterward obſerved, as we expected, that the fumes did not mount and diſperſe themſelves as they uſed to do in the open air; but that, when by reaſon of the agitation of the corpuſcles of the liquor, which could not continue their motion in ſo narrow a ſpace as the phial afforded them, and were therefore reduced to thruſt one another out of it; when, I ſay, by theſe aſſiſtances the fumes were aſcended to the lip of the phial, they mounted no higher, but ran down along the outſide of the phial to the bottom of it; and thence along a long and inclining piece of lead, on which the phial reſted, like a little ſtream (not very much bigger than a ſwan's quill) whoſe nature they ſeemed to emulate ſo well, that it quitted not the phial till it was come to the bottom of it, and then forſook it in ſuch a manner, as a ſtream of water of the ſame bigneſs would have done. And this ſtream laſted a pretty while, and would probably have laſted longer, but that being loth to waſte my liquor, I let in at the ſtop-cock a pretty deal of the external air; notwithſtanding which, finding after a while that the ſtream did run afreſh, though as it ſeemed not altogether ſo copious as before, I let as much more air as would come in; and found (ſomewhat to my wonder) that though the ſtream formerly mentioned diſappeared, yet there appeared not any white fumes to ariſe, either from the cork, or out of the phial it ſelf, no not when the cover was removed from the receiver: though not only after a while there aſcended white fumes from the receiver, but having forthwith taken out the phial into the open air, it emitted white exhalations as before. And having preſently after unſtopped it in an open window, we found both it and the cork immediately to ſend forth a yet much more plentiful ſmoke. Though it be now divers years ſince this numerical liquor was prepared, after the manner mentioned either by *Carneades* or *Eleutherius* (for I do not well remember which) in thoſe *Dialogues concerning heat and flame* that have been above mentioned.

MORE circumſtances concerning theſe fumes we might have obſerved, had we not been deterred by an indiſpoſition in point of health, from having much to do with ſteams of ſo dangerous a nature, as by that of the ingredients of this liquor theſe ſeem likely to be of.

THE reflections, that may be made upon this experiment, we have not now the leiſure to proſecute; and therefore ſhall content our ſelves to recommend the ſeveral circumſtances of it to your Lordſhip's ſerious conſideration; and to take notice (*en paſſant*) that ſteams in an ambient body, or a medium thinner than themſelves, may both tend downwards, and otherwiſe emulate the nature of a liquor: which I therefore point at, that it may appear the leſs ſtrange, if we ſometimes ſpeak of the atmo-

ſphere

ſphere as of a kind of liquor, in compariſon of that more thin and ſubtile celeſtial matter, that ſurrounds it.

AND though it might perchance ſuffice to have on this occaſion intimated thus much; yet, leſt this way of ſpeaking of the atmoſphere ſhould be thought too bold and extravagant, I am content to borrow an experiment of the diſcourſe formerly mentioned (touching *fluidity and firmneſs*,) and ſubjoin it here with alterations ſuitable to the contrivance of our engine; and this the rather, becauſe I hope it may conduce to the diſcovery of the nature of the atmoſphere: for which reaſon it might have been annexed to what hath been noted either upon the firſt, or eighteenth experiment, but that when they were written and ſent away, it came not into my mind. The experiment then, as we tried in our engine, was as follows.

EXPERIMENT XXX.

WE took one of the ſmall receivers, often mentioned already, and into it we conveyed a piece of well-lighted match; and letting it remain there, till it had filled the receiver with ſmoke, we took it out and haſtily cloſed again the receiver, that the ſmoke might not get away. Then ſtaying a while to let theſe fumes leiſurely ſubſide, we found, as we expected, that after ſome time they ſettled themſelves in the lower half of the receiver, in a darkiſh body, leaving the upper half of the receiver tranſparent, and, as to ſight, full of nought but clear air. Now to manifeſt, that this ſmoke thus ſettled emulated a liquor, we inclined the engine that contained it ſometimes to one ſide, and ſometimes to the other; and obſerved the ſmoke to keep its ſurface almoſt horizontal, notwithſtanding the ſtooping of the veſſel that held it, as water, or another liquor, would in the like caſe have done. And if by a quicker rocking of the engine the ſmoke were more ſwiftly ſhaken, it would, like water, either vibrate to and fro from one ſide to the other of the glaſs, or elſe have its ſurface manifeſtly curled with waves, but preſerve it ſelf in an entire and diſtinct body from the incumbent air; and being permitted to reſt a while, would ſoon recover its former ſmooth and level ſuperficies. If alſo the key were turned, and the valve unſtopped, ſo that there was a free, though but a narrow paſſage opened betwixt the external air and the cavity of the receiver, then would ſome of this ſmoke fall down, as it were, in a ſtream into the ſubjacent cylinder, and a proportionate quantity of the outward air would manifeſtly aſcend through it into the incumbent air, much after the ſame manner as if you invert a phial with a long neck, and well filled with red-wine, into a glaſs full of fair water, you ſhall ſee the water and wine by degrees mingle with one another; the one falling down as it were in little coloured ſtreams, and the other aſcending in its room in the like curled ſtreams, ſometimes preceded by round parcels of water, which, by reaſon of their tranſparency, look almoſt like bubbles. The other circumſtances of this experiment, belonging not all of them to our preſent purpoſe, we ſhall content our ſelves with taking notice of one, which ſeems the moſt important, and may illuſtrate and confirm ſome things formerly delivered. And it was, that if, when the ſuperficies of our ſmoke lay ſmooth and horizontal, a hot iron were held near the outſide of the receiver, the neighbouring part of the included fumes (for the reſt did not very much alter their former ſuperficies) being rarefied by the heat, would readily aſcend in a large pillar of ſmoke to the very top of the receiver, yet without ſeeming to loſe a diſtinct ſuperficies, or to be confounded with air; below which, upon the receſs of the adventitious heat, that by agitating it impelled it upward, it would again ſubſide.

ALL which being added to the late experiment of the ſmoking liquor, and to what may be from that, which hath been elſewhere ſaid, gathered to the ſame purpoſe, will, I hope, keep it at leaſt from appearing abſurd; if, (ſince we ſee, that there is ſo great an inequality in the denſity and weight of liquors, that water is near fourteen times thinner or lighter than quickſilver of the ſame bulk, and well dephlegmed ſpirit of wine, yet much lighter than water,) we venture to ſpeak ſometimes of the atmoſphere, as if it were a peculiar kind of thin and halitious liquor (if I may ſo call it) much lighter than ſpirit of wine.

To theſe things I know not whether it will be requiſite to add, that as we lately took notice of conſpicuous waves, that appeared upon the ſuperficies of our agitated ſmoke, ſo ſome ſuch thing may not abſurdly be conjectured to happen on the ſuperficies of the atmoſphere, by thoſe ſtrange ruggedneſſes, that appear (eſpecially in the ſpring and fall, when exhalations and vapours are wont to aſcend moſt plentifully) upon the limb or edge of the riſing and ſetting ſun. I ſpeak thus diffidently upon this occaſion, becauſe I know, that by the fluctuation or boiling of the ſun's own ſuperficies, divers eminent mathematicians have plauſibly enough (but how truly, I leave your Lordſhip to judge) endeavoured to give an account of it. But if we will join with thoſe, that have aſcribed of late this phænomenon to the refraction the ſun-beams ſuffer in our vapid air, we may, as hath been intimated, promote their doctrine, by deducing from it, that probably the ſurface of the atmoſphere is oftentimes (if not always) exceedingly curled or waved. And certainly it is ſomewhat wonderful, as well as very pleaſant to behold, how, to him that looks upon the ſetting ſun through a long and excellent teleſcope, there will not only appear ſtrange inequalities in the edge of it (inſomuch that I have often ſeen it more indented than a ſaw) but thoſe inequalities will vaniſh in one place, and preſently appear in another, and ſeem perfectly to move like waves ſucceeding and deſtroying one another, ſave that their motion oftentimes ſeems to be quickeſt, as if in that vaſt ſea they were carried on by a current, or at leaſt by a tide. And this (as we elſewhere note) appears to the eye, not only when it looks directly through the teleſcope upon the

ſun,

ſun, but alſo when a large and well-defined image of the ſun is by the ſame teleſcope brought into a room and caſt upon a ſheet of white paper. But to inſiſt on this were to digreſs; and therefore I will proceed to experiments of another kind.

EXPERIMENT XXXI.

IT hath been admir'd by very ingenious men, that if the exquiſitely poliſhed ſurfaces of two flat pieces of marble be ſo congruous to each other, that from their mutual application there will reſult an immediate contact, they will ſtick ſo faſt together, that he, that lifts up the uppermoſt, ſhall, if the undermoſt be not exceeding heavy, lift up that too, and ſuſtain it aloft in the free air. A probable cauſe of this ſo cloſe adheſion we have elſewhere endeavoured to deduce from the unequal preſſure of the air upon the undermoſt ſtone; for the lower ſuperficies of that ſtone being freely expoſed to the air, is preſſed upon by it, whereas the uppermoſt ſurface, being contiguous to the ſuperior ſtone, is thereby defended from the preſſure of the air; which conſequently preſſing the lower ſtone againſt the upper, hinders it from falling, as we have elſewhere more fully declared. Upon theſe grounds we conjectured, that in caſe we could procure two marbles exactly ground to one another, and in caſe we could alſo ſufficiently evacuate our receiver; the lower ſtone would, for want of the wonted and ſuſtaining preſſure of the air, fall from the upper. But the farther trial of this experiment we muſt, unleſs your Lordſhip think it worth your making at *Paris*, put off till a fitter opportunity. For where we now are, we cannot procure marbles ſo exactly ground, that they will ſuſtain one another in the air above a minute or two, which is a much ſhorter time than the emptying of our receiver requires. We did indeed try to make our marbles ſtick cloſe together, by moiſtening their poliſhed ſurfaces with rectified ſpirit of wine, in regard that liquor, by its ſudden avolation from marble, if poured thereon, without leaving it moiſt or leſs ſmooth, ſeemed unable to ſuſtain them together after the manner of a glutinous body, and yet ſeemed ſufficient to exclude and keep out the air. But this we tried to little purpoſe, for having conveyed into the receiver two black ſquare marbles (the one of two inches and a third in length or breadth, and ſomewhat more than half an inch in thickneſs; the other of the ſame extent, but not much above half ſo thick) faſtened together by the intervention of pure ſpirit of wine; and having ſuſpended the thicker by a ſtring from the cover, we found not, that the exſuction of the ambient air would ſeparate them, though a weight amounting to four ounces were faſtened to the lowermoſt marble to facilitate its falling of.

I WOULD gladly have the experiment tried with marble ſo well poliſhed, as to need no liquor whatſoever to make them cohere, and in a veſſel, out of which the air may be more perfectly drawn than it was out of ours. But in the mean time, though we will not determine whether the ſpirit of wine did contribute to the ſtrong coheſion of theſe ſtones, otherwiſe than by keeping even the ſubtleſt parts of the air from getting in between them; yet it ſeemed, that the not falling down, of the lowermoſt marble might, without improbability, be aſcribed to the preſſure of the air remaining in the receiver: which, as we formerly noted, having been able to keep a cylinder of water, of above a foot in height, from falling to the bottom of the tube, may well enough be ſuppoſed capable of keeping ſo broad a flat marble from deſcending. And though this may ſeem a ſtrange proof of the ſtrength of the ſpring of the air, even when rarefied, yet it will ſcarce ſeem incredible to him, that hath obſerved, how exceeding ſtrong a coheſion may be made betwixt broad bodies, only by their immediate touching one another. A notable inſtance of which I met with in this ſhort narrative of the learned *Zucchius*: *Juveni* (ſaith he) *lacertorum ſuorum robur jactanti propoſita ſemel eſt lamina ærea, per anſam in medio extantem apprehenſam elevanda è tabula marmorea, cui optime congruebat: qui primo tanquam rem ludicram puero committendam contempſit; tum inſtantibus amicis manum utrámque admovens, cum luctatus diu hærentem non removiſſet, excuſavit impotentiam, objecta peregrini & potentiſſimi glutinis interpoſitione, quo fortiſſime copulante nequiret divelli; donec vidit ab alio per tabulam facillimè laminam deduci, & ad extrema productam, & actam in tranſverſum indè deportari.* But that we may learn from our own engine, that two bodies, though they touch each other but in a ſmall part of their ſurfaces, may be made to cohere very ſtrongly, only by this, that the air preſſes much more forcibly upon the inferiour ſuperficies of the lowermoſt body, than upon the upper ſurface of the ſame; we will hereunto annex the following experiment, though out of the order, wherein they were made.

P. Nic. Zucchius apud Schot. part 1. Mec. Hydraulopneum.

EXPERIMENT XXXII.

I Remember I have, in a diſcourſe touching fluidity and firmneſs, made mention of my having, by the exſuction of the air out of a glaſs veſſel, made that veſſel take up, or ſuck up (to ſpeak in the common language) a body weighing divers ounces; but our engine affording us the opportunity of making conſiderabler experiments of that kind, we thought fit to make a further trial of the force of the atmoſphere's preſſure upwards, after the following manner.

THE receiver having been exquiſitely cloſed, as we have often taught already, and the air being in a good meaſure drawn out of it, it was removed from off the pump: and to the lower branch of the ſtop-cock, there was ſpeedily applied a tapering valve of braſs, ſuch as is deſcribed in the 9th figure, made fit to go with its narrower end into the cavity of the branch, and to fill the orifice of that cavity with its broader part. And that the air might not get in at the little intervals, left here and there between the convex ſurface of the ſtopple

and the internal edge of the branch, thoſe intervals were ſtopt with a little diachylon. And to the door, or (if you pleaſe) that part of the valve, which was to move to and fro, and in this experiment hung perpendicular to the horizon, there was, at a button of braſs belonging to the valve, faſtened a broad ſcale, wherein weights were to be put. This done, the key of the ſtop-cock was turned, and the external air beating like a forcible ſtream upon the valve to get in there, it did ſuddenly both ſhut the valve, and keep it ſhut ſo ſtrongly, that we had time to caſt in divers weights one after another into the ſcale; till at length the weight overpowering the preſſure of the atmoſphere, drew down the valve by the ſtrings that tied the ſcale to it, and gave liberty to the outward air to ruſh into the receiver. Though another time, when the valve had but little weight hanging at it, being, by I know not what accident, drawn down beneath its former place, it was by the impetuous current of the outward air ſuddenly impelled up into it again, and kept there. But in the former experiment it is remarkable, that though the receiver were not well exhauſted, and though it leaked, whilſt the reſt of the experiment was in proſecution; and though the valve, whereon the cylinder of the atmoſphere could preſs, were not above an inch and a half in diameter, yet the weight kept up by ſuction, or rather ſupported by the air, (namely the valve, the ſcale, and what was caſt out of it,) being ſent to be weighed, amounted to about ten of our common pounds, conſiſting of ſixteen ounces a piece; ſo that we doubted not, but that, had the experiment been made with favourable circumſtances, the air endeavouring to preſs in at the orifice of the ſtop-cock, would have kept a very much greater weight from falling out of it; I ſay the air, becauſe we found, by trial purpoſely made, that neither the imperfect contact of the valve and the ſtop-cock, nor the diachylon, that was employed to fill up the little crannies left betwixt them, were conſiderable in this experiment. By which it may, among other things, appear, that I did not without cauſe, in the above-named diſcourſe touching fluidity and firmneſs, aſcribe a great force, even to ſuch pillars of air, as may be ſuppoſed to begin at the top of the atmoſphere, and recoiling from the ground, to terminate on the bodies on which they preſs; ſince in the preſent experiment ſuch a weight was ſupported by ſo ſlender a cylinder of air, rebounding from the earth to the valve, whereon it did bear.

EXPERIMENT XXXIII.

BUT in regard we have not yet been able to empty ſo great a veſſel as our receiver, ſo well as we can the cylinder itſelf; our pump alone may afford us a nobler inſtance of the force of the air we live in, inſomuch, that by help of this part of our engine, we may give a pretty near gueſs at the ſtrength of the atmoſphere, computed as a weight. And the way may be this; firſt, the ſucker being brought to move eaſily up and down the cylinder, is to be impelled to the top of it: then the receiver muſt be taken off from the pump, that the upper orifice of the cylinder remaining open, the air may freely ſucceed the ſucker, and therefore readily yield to its motion downwards. This done, there muſt be faſtened to one of the iron teeth of the ſucker ſuch a weight as may juſt ſuffice to draw it to the bottom of the cylinder. And having thus examined, what weight is neceſſary to draw down the ſucker, when the atmoſphere makes no other than the ordinary reſiſtance of the air againſt its deſcent; the ſucker muſt be again forced to the top of the cylinder, whoſe upper orifice muſt now be exactly cloſed; and then (the firſt weight remaining) we eaſily may, by hanging a ſcale to the above mentioned iron (that makes part of the ſucker) caſt in known weights ſo long, till in ſpite of the reluctancy of the atmoſphere the ſucker be drawn down. For to theſe weights in the ſcale that of the ſcale itſelf being added, the ſum will give us the weight of a column of air, equal in diameter to the ſucker, or to the cavity of the cylinder, and in length to the height of the atmoſphere.

ACCORDING to this method we did, ſince the writing of the laſt experiment, attempt to meaſure the preſſure of the atmoſphere, but found it more difficult than we expected to perform it with any accurateneſs; for though by the help of the manubrium the ſucker moved up and down with ſo much eaſe, that one would have thought, that both its convex ſurface, and the concave one of the cylinder were exquiſitely ſmooth, and as it were ſlippery; yet when the ſucker came to be moved only with a dead weight or preſſure (that was not, like the force of him that pumped, intended as occaſion required) we found, that the little roughneſſes or other inequalities, and perhaps too the unequal preſſure of the leather againſt the cavity of the cylinder, were able, now and then, to put a ſtop to the deſcent or aſcent of the ſucker, though a very little external help would eaſily ſurmount that impediment; and then the ſucker would, for a while, continue its formerly interrupted motion, though that aſſiſtance were withdrawn. But this diſcouragement did not deter us from proſecuting our experiment, and endeavouring, by a careful trial, to make it as inſtructive as we could. We found then, that a leaden weight, of 28 pounds (each conſiſting of ſixteen ounces) being faſtened to one of the teeth of the ſucker, drew it down cloſely enough, when the upper orifice of the cylinder was left open, though by the help of oil and water, and by the frequent moving the ſucker up and down with the manubrium, its motion in the cylinder had been before purpoſely facilitated. This done, the upper orifice of the cylinder was very carefully and cloſely ſtopt, the valve being likewiſe ſhut with its wonted ſtopple well oiled, after the ſucker had been again impelled up to the top of the cylinder. Then to the precedent twenty-eight pound we added a hundred and twelve pounds more; which forcing down the ſucker, though but leiſurely, we took off the twenty-eight pound weight; and being unable to procure

cure juſt ſuch weights as we would have had, we hung on, inſtead of it, one of fourteen pound; but found that, with the reſt, unable to carry down the ſucker. And to ſatisfy our ſelves, and the ſpectators, that it was the reſiſtance of the ambient air, that hindered the deſcent of ſo great a weight, after that we had tried, that upon unſtopping the valve, and thereby opening an acceſs to the external air, the ſucker would be immediately drawn down; after this, I ſay, we made this farther experiment, that having by a man's ſtrength forcibly depreſſed the ſucker to the bottom of the cylinder, and then faſtened weights to the above-named iron, that makes part of that ſucker, the preſſure of the external air finding little or nothing in the cavity of the evacuated cylinder to reſiſt it, did preſently begin to impel the ſucker, with the weights that clogged it, towards the upper part of the cylinder; till ſome ſuch accidental impediment, as we formerly mentioned, checked its courſe. And when that rub (which eaſily might be,) was taken out of the way, it would continue its aſcent to the top, to the no ſmall wonder of thoſe byſtanders, that could not comprehend, how ſuch a weight could aſcend, as it were, of itſelf; that is, without any inviſible force, or ſo much as ſuction to lift it up. And indeed it is very conſiderable, that though poſſibly there might remain ſome particles of air in the cylinder, after the drawing down of the ſucker; yet the preſſure of a cylinder of the atmoſphere, ſomewhat leſs than three inches in diameter (for, as it was ſaid in the deſcription of our engine, the cavity of the cylinder was no broader) was able, uncompreſſed, not only to ſuſtain, but even to drive up a weight of a hundred and odd pounds: for beſides the weight of the whole ſucker itſelf, which amounts to ſome pounds, the weights annexed to it made up an hundred and three pounds, beſides an iron bar, that by conjecture weighed two pounds more; and yet all theſe together fall ſomewhat ſhort of the weight, which we lately mentioned the reſiſtance of the air to have held ſuſpended in the cavity of the cylinder.

AND though (as hath been already acknowledged) we cannot peradventure obtain by the recited means ſo exact an account as were to be wiſhed, of what we would diſcover; yet, if it ſerve us to ground conjectures more approaching to the truth, than we have hitherto met with, I hope it will be conſidered (which a famous poet judiciouſly ſays,)

Eſt quoddam prodire tenus, ſi non datur ultra.

PERADVENTURE it will not be impertinent to annex to the other circumſtances, that have been already ſet down concerning this experiment, that it was made in winter, in weather neither froſty nor rainy, about the change of the moon, and at a place whoſe latitude is near about 51 degrees and a half; for perhaps the force or preſſure of the air may vary, according to the ſeaſons of the year, the temperature of the weather, the elevation of the pole, or the phaſes of the moon; all, or even any of them ſeeming capable to alter either the height or conſiſtence of the incumbent atmoſphere: and therefore it would not be amiſs, if this experiment were carefully tried at ſeveral times and places, with variety of circumſtances. It might alſo be tried with cylinders of ſeveral diameters, exquiſitely fitted with ſuckers, that we might know, what proportion ſeveral pillars of the atmoſphere bear to the weights they are able to ſuſtain or lift up; and conſequently, whether the increaſe or decrement of the reſiſtance of the ambient air can be reduced to any regular proportion to the diameters of the ſuckers. Theſe, and divers other ſuch things, which may be tried with this cylinder, might moſt of them be more exactly tried by the Torricellian experiments, if we could get tubes ſo accurately blown and drawn, that the cavity were perfectly cylindrical.

To dwell upon all the ſeveral reflexions, that a ſpeculative wit might make upon this and the foregoing experiment, (I mean the thirty-third and thirty-ſecond) would require almoſt a volume; whereas our occaſions will ſcarce allow us time to touch upon three or four of the chief inferences, that ſeem deducible from them, and therefore we ſhall content our ſelves to point at thoſe few.

AND firſt, as many other phænomena of our engine, ſo eſpecially the two lately mentioned experiments ſeem very much to call in queſtion the received opinion of the nature or cauſe of ſuction. For it is true indeed, that when men ſuck, they commonly uſe ſome manifeſt endeavour, by a peculiar motion of their mouths, cheſts, and ſome other conſpiring parts, to convey to them the body to be ſucked in. And hence perhaps they have taken occaſion to think, that in all ſuction there muſt be ſome endeavour or motion in the ſucking to attract the ſucked body. But in our laſt experiment it appears not at all, how the upper part of the emptied cylinder, that remains moveleſs all the while, or any part of it, doth at all endeavour to draw to it the depreſſed ſucker and the annexed weights. And yet thoſe, that behold the aſcenſion of the ſucker, without ſeriouſly conſidering the cauſe of it, do readily conclude it to be raiſed by ſomething, that powerfully ſucks or attracts it, though they ſee not what that may be, or where it lurks. So that it ſeems not abſolutely neceſſary to ſuction, that there be in the body, which is ſaid to ſuck, an endeavour or motion in order thereunto; but rather that ſuction may be at leaſt for the moſt part reduced to pulſion, and its effects aſcribed to ſuch a preſſure of the neighbouring air upon thoſe bodies (whether aërial, or of other natures) that are contiguous to the body, that is ſaid to attract them, as is ſtronger, than that ſubſtance, which poſſeſſeth the cavity of that ſucking body, is able to reſiſt. To object here, that it was ſome particles of air remaining in the emptied cylinder, that attracted this weight to obviate a vacuum, will ſcarce be ſatisfactory; unleſs it can be clearly made out, by what little hooks, or other grappling inſtruments, the internal air could take hold of the ſucker; how ſo little of it obtained the force to lift up ſo great a weight; and why alſo, upon the letting

in of a little more air into one of our evacuated veſſels, the attraction is, inſtead of being ſtrengthened, much weakened; though, if there were danger of a vacuum before, it would remain, notwithſtanding this ingreſs of a little air. For that ſtill there remained in the capacity of the exhauſted cylinder ſtore of little rooms, or ſpaces empty or devoid of air, may appear by the great violence, wherewith the air ruſheth in, if any way be opened to it. And that it is not ſo much the decrement of the vacuum within the cavity of the veſſel, that debilitates the attraction, as the ſpring of the included air (whoſe preſence makes the decrement) that doth it by reſiſting the preſſure of the external air, ſeems probable, partly from the diſability of vacuities, whether greater or leſſer, to reſiſt the preſſure of the air; and partly by ſome of the phænomena of our experiments, and particularly by this circumſtance of the three and thirtieth, that the ſucker was, by the preſſure of the ambient air, impelled upwards with its weight hanging at it, not only when it was in the bottom of the cylinder, and conſequently left a great vacuum in the cavity of it; but when the ſucker had been already impelled almoſt to the top of the cylinder, and conſequently, when the vacuum that remained was become very little in compariſon of that, which preceded the beginning of the ſucker's aſcenſion.

IN the next place, theſe experiments may teach us, what to judge of the vulgar axiom received for ſo many ages as an undoubted truth in the Peripatetick ſchools, that nature abhors and flieth a vacuum, and that to ſuch a degree, that no human power (to go no higher) is able to make one in the univerſe; wherein heaven and earth would change places, and all its other bodies rather act contrary to their own nature, than ſuffer it. For, if by a vacuum we will underſtand a place perfectly devoid of all corporeal ſubſtance, it may indeed then, as we formerly noted, be plauſibly enough maintained, that there is no ſuch thing in the world. But that the generality of the Pleniſts, (eſpecially till of late years ſome of them grew more wary) did not take a vacuum in ſo ſtrict a ſenſe, may appear by the experiments formerly, and even to this day imployed by the denyers of a vacuum, to prove it impoſſible, that there can be any made. For when they alledge (for inſtance) that when a man ſucks water through a long pipe, that heavy liquor, contrary to its nature, aſcends into the ſucker's mouth, only to fill up that room made by the dilatation of his breaſt and lungs, which otherwiſe will in part be empty: and when they tell us, that the reaſon, why if a long pipe exactly cloſed at one end be filled top-full of water, and then inverted, no liquor will fall out of the open orifice; or, to uſe a more familiar example, when they teach, that the cauſe, why in a gardener's watering pot ſhaped conically or like a ſugar-loaf, filled with water, no liquor falls down through the numerous holes at the bottom, whilſt the gardener keeps his thumb upon the orifice of the hole at the top, and no longer; muſt be, that if in the caſe propoſed the water ſhould deſcend, the air being unable to ſucceed it, there would be left at the upper and deſerted part of the veſſel a vacuum, that would be avoided, if the hole at the top were opened: When (I ſay) they alledge ſuch experiments, the tendency of them ſeems plainly to import, that they mean, by a vacuum, any ſpace here below, that is not filled with a viſible body, or at leaſt with air, though it be not quite devoid of all body whatſoever. For why ſhould nature, out of her deteſtation of a vacuum, make bodies act contrary to their own tendency, that a place may be filled with air, if its being ſo were not neceſſary to the avoiding of a vacuum?

TAKING then a vacuum in this vulgar and obvious ſenſe, the common opinion about it ſeems liable to ſeveral exceptions, whereof ſome of the chief are ſuggeſted to us by our engine.

IT will not eaſily then be intelligibly made out, how hatred or averſation, which is a paſſion of the ſoul, can either for a vacuum, or any other object, be ſuppoſed to be in water, or ſuch like inanimate body, which cannot be preſumed to know, when a vacuum would enſue, if they did not beſtir themſelves to prevent it; nor to be ſo generous as to act contrary to what is moſt conducive to their own particular preſervation for the public good of the univerſe. As much then of intelligible and probable truth, as is contained in this metaphorical expreſſion, ſeems to amount but to this; that by the wiſe author of nature (who is juſtly ſaid to have made all things in number, weight and meaſure,) the univerſe, and the parts of it, are ſo contrived, that it is as hard to make a vacuum in it, as if they ſtudiouſly conſpired to prevent it. And how far this itſelf may be granted, deſerves to be farther conſidered.

FOR, in the next place, our experiments ſeem to teach, that the ſuppoſed averſation of nature to a vacuum is but accidental, or in conſequence, partly of the weight and fluidity, or, at leaſt, fluxility of the bodies here below; and partly, and perhaps principally, of the air, whoſe reſtleſs endeavour to expand itſelf every way makes it either ruſh in itſelf, or compel the interpoſed bodies into all ſpaces, where it finds no greater reſiſtance than it can ſurmount. And that in thoſe motions which are made *ob fugam vacui* (as the common phraſe is) bodies act without ſuch generoſity and conſideration, as is wont to be aſcribed to them, is apparent enough in our 32[d] experiment, where the torrent of air, that ſeemed to ſtrive to get into the emptied receiver, did plainly prevent its own deſign, by ſo impelling the valve, as to make it ſhut the only orifice the air was to get out at. And if afterwards either nature, or the internal air had a deſign the external air ſhould be attracted, they ſeemed to proſecute it very unwiſely by continuing to ſuck the valve ſo ſtrongly, when they found, that by that ſuction the valve itſelf could not be drawn in; whereas by forbearing to ſuck, the valve would by its own weight have fallen down, and ſuffered the excluded air to return freely, and to fill again the exhauſted veſſel.

AND

AND this minds me to take notice of another deficiency, pointed at by our experiments in the common doctrine of thoſe Pleniſts we reaſon with; for many of thoſe unuſual motions in bodies, that are ſaid to be made to eſcape a vacuum, ſeem rather made to fill it. For why, to inſtance in our newly mentioned experiment, as ſoon as the valve was depreſſed by the weight we hung at it, ſhould the air ſo impetuouſly and copiouſly ruſh into the cavity of the receiver, if there were before no vacant room there to receive it? And if there were, then all the while the valve kept out the air, thoſe little ſpaces in the receiver, which the corpuſcles of that air afterwards filled, may be concluded to have remained empty. So that the ſeeming violence, imployed by nature on the occaſion of the evacuating of the veſſel, ſeems to have come too late to hinder the making of vacuities in the receiver, and only to have, as ſoon as we permitted, filled up with air thoſe that were already made.

AND as for the care of the public good of the univerſe aſcribed to dead and ſtupid bodies, we ſhall only demand, why in our 19th experiment, upon the exſuction of the ambient air, the water deſerted the upper half of the glaſs-tube; and did not aſcend to fill it up, till the external air was let in upon it. Whereas by its eaſy and ſudden regaining that upper part of the tube, it appeared both that there was there much ſpace devoid of air, and that the water might with ſmall or no reſiſtance have aſcended into it, if it could have done ſo without the impulſion of the re-admitted air; which, it ſeems, was neceſſary to mind the water of its formerly neglected duty to the univerſe.

NAY, for aught appeareth, even when the excluded air, as ſoon as it was permitted, ruſhed violently into our exhauſted receiver, that flowing in of the air proceeded rather from the determinate force of the ſpring of the neighbouring air, than from any endeavour to fill up, much leſs to prevent vacuities. For though, when as much air as will, is gotten into our receiver, our preſent opponents take it for granted, that it is full of air; yet if it be remembred, that when we made our 17th experiment, we crouded in more air to our receiver than it uſually holds; and if we alſo conſider (which is much more) that the air of the ſame conſiſtence with that in our receiver may in wind-guns, as is known, and as we have tried, be compreſſed at leaſt into half its wonted room (I ſay, at leaſt, becauſe ſome affirm, that the air may be thruſt into an 8th, or a yet ſmaller part of its ordinary extent) it ſeems neceſſary to admit either a notion of condenſation and rarefaction, that is not intelligible, or that in the capacity of our receiver, when preſumed to be full of air, there yet remained as much of ſpace as was taken up by all the aërial corpuſcles, unpoſſeſſed by the air. Which ſeems plainly to infer, that the air, that ruſhed into our emptied veſſel, did not do it preciſely to fill up the vacuities of it, ſince it left ſo many unfilled, but rather was thruſt in by the preſſure of the contiguous air: which as it could not but be always ready to expand it ſelf, where it found leaſt reſiſtance, ſo was it unable to fill the receiver any more, than until the air within was reduced to the ſame meaſure of compactneſs with that without.

WE may alſo from our two already oftenmentioned experiments farther deduce, that (ſince nature's hatred of a vacuum is but metaphorical and accidental, being but a conſequence or reſult of the preſſure of the air and of the gravity, and partly alſo of the fluxility of ſome other bodies) the power ſhe makes uſe of to hinder a vacuum, is not (as we have elſewhere alſo noted) any ſuch boundleſs thing, as men have been pleaſed to imagine. And the reaſons, why in the former experiments, mentioned in favour of the Pleniſts, bodies ſeem to forget their own natures to ſhun a vacuum, ſeems to be but this; that in the alledged caſes the weight of that water, that was either kept from falling or impelled up, was not great enough to ſurmount the preſſure of the contiguous air; which, if it had been, the water would have ſubſided, though no air could have ſucceeded. For not to repeat that experiment of Monſieur *Paſchal* (formerly mentioned to have been tried in a glaſs exceeding 32 foot) wherein the inverted pipe being long enough to contain a competent weight of water, that liquor freely ran out at the lower orifice: not to mention this (I ſay) we ſaw in our nineteenth experiment, that when the preſſure of the ambient air was ſufficiently weakened, the water would fall out apace at the orifice even of a ſhort pipe, though the air could not ſucceed into the room deſerted by it. And it were not amiſs, if trial were made on the tops of very high mountains, to diſcover with what eaſe a vacuum could be made near the confines of the atmoſphere, where the air is probably but light in compariſon of what it is here below. But our preſent (three and thirtieth) experiment ſeems to manifeſt, not only that the power, exerciſed by nature, to ſhun or repleniſh a vacuum is limited, but that it may be determined even to pounds and ounces: inſomuch that we might ſay, ſuch a weight nature will ſuſtain or will lift up to reſiſt a vacuum in our engine; but if an ounce more be added to that weight, it will ſurmount her ſo much magnified deteſtation of vacuities. And thus, my Lord, our experiments may not only anſwer thoſe of the Pleniſts, but enable us to retort their arguments againſt themſelves; ſince, if that be true, which they alledge, that when water falls not down according to its nature, in a body, wherein no air can ſucceed to fill up the place it muſt leave, the ſuſpenſion of the liquor is made, *ne detur vacuum*, (as they ſpeak) it will follow, that if the water can be brought to ſubſide in ſuch a caſe, that deſerted ſpace may be deemed empty, according to their own doctrine; eſpecially, ſince nature (as they would perſuade us) beſtirs her ſelf ſo mightily to keep it from being deſerted.

I hope I ſhall not need to remind your Lordſhip, that I have all this while been ſpeaking of a vacuum, not in the ſtrict and philoſophi-

tal ſenſe, but in that more obvious and familiar one, that hath been formerly declared.

AND therefore I ſhall now proceed to obſerve in the laſt place, that our 33[d] experiment affords us a notable proof of the unheeded ſtrength of that preſſure, which is ſuſtained by the corpuſcles of what we call the free air, and preſume to be uncompreſſed. For, as fluid and yielding a body as it is, our experiment teacheth us, that even in our climate, and without any other compreſſion than what is (at leaſt here below) natural, or (to ſpeak more properly) ordinary to it, it bears ſo ſtrongly upon the bodies, whereunto it is contiguous, that a cylinder of this free air, not exceeding three inches in diameter, is able to raiſe and carry up a weight, amounting to between ſixteen and ſeventeen hundred ounces. I ſaid, even in our climate, becauſe that is temperate enough; and as far as my obſervations aſſiſt me to conjecture, the air in many other more northern countries may be much thicker, and able to ſupport a greater weight: which is not to be doubted of, if there be no miſtake in what is recorded concerning the * Hollanders, that were forced by the ice to winter in *Nova Zembla*, namely, that they found there ſo condenſed an air, that they could not make their clock go, even by a very great addition to the weights, that were wont to move it.

I ſuppoſe your Lordſhip will readily take notice, that I might very eaſily have diſcourſed much more fully and accurately than I have done, againſt the common opinion touching ſuction, and touching nature's hatred of a vacuum. But I was willing to keep my ſelf to thoſe conſiderations touching theſe matters, that might be verified by our engine it ſelf; eſpecially ſince, as I ſaid at firſt, it would take up too much time to inſiſt particularly upon all the reflections, that may be made even upon our two laſt experiments. And therefore paſſing to the next, I ſhall leave it to your Lordſhip to conſider, how far theſe trials of ours will either confirm or diſfavour the new doctrine of ſeveral eminent Naturaliſts, who teach, that in all motion there is neceſſarily a circle of bodies, as they ſpeak, moving together; and whether the circles in ſuch motion be an accidental or conſequential thing or no.

EXPERIMENT XXXIV.

IT is a known thing to thoſe, that are converſant in the hydroſtatickshat, ttwo bodies, which in the air are of equal weight, but of unequal bulk, as gold for inſtance, and iron, being afterwards weighed in water, will loſe their æquilibrium upon the change of the ambient body: ſo that the gold will ſink lower than the iron; which, by reaſon of its greater bulk, hath more water to lift or diſplace, that it may ſink. By analogy to this experiment, it ſeemed probable, that if two weights did in our engine balance each other, when the glaſs was full of air; upon the exſuction of a great part of that air, ſo notable a change in the conſiſtence of the ambient body would make them loſe their æquilibrium.

BUT being deſirous at the ſame time to make a trial, for a certain deſign, that needs not here be mentioned, we took for one of our weights a dry bladder, ſtrongly tied at the neck, and about half filled with air, (that being a weight both ſlight, and that would expand it ſelf in the evacuated glaſs) and faſtening that to one part of our formerly mentioned exact balance, (which turns with the 32[d] part of a grain) we put a metalline counterpoiſe into the oppoſite ſcale; and ſo the two weights being brought to an æquilibrium, the balance was conveyed into the receiver, and ſuſpended from the cover of it.

BUT before we proceed farther, we muſt note, that preſently after the laying on of the cover, the bladder appeared to preponderate; whereupon the ſcales being taken out, and reduced very near to an æquilibrium, yet ſo, that a little advantage remained on that ſide, to which the metalline weight belonged; they were again let down into the receiver, which was preſently made faſt with plaiſter, and a hot iron: ſoon after which, before the pump was employed, the bladder ſeemed again a little to preponderate. Afterwards the air in the glaſs being begun to be drawn out, the bladder began (according to the formerly mentioned obſervations) to expand it ſelf, and manifeſtly to outweigh the oppoſite weight, drawing down the ſcale, to which it was faſtened, very much beneath the other, eſpecially when the air had ſwelled it to its full extent.

THIS done, we very leiſurely let in the external air; and obſerved, that upon the flagging of the bladder, the ſcale, whereto it was faſtened, not only by degrees returned to an æquilibrium with the other, but at length was a little outweighed by it.

BUT becauſe we ſuſpected there might have intervened ſome unheeded circumſtance in this laſt part of the experiment, we would not preſently take out the ſcales, nor meddle with the cover; but leaving things as they were, we perceived, that after a little while the bladder began again to preponderate, and by degrees to ſink lower and lower for divers hours; wherefore, leaving the veſſel cloſed up all night, we repaired to it next morning, and found the bladder fallen yet lower; as if the very ſubſtance of it had imbibed ſome of the moiſture wherewith the air (the ſeaſon being very rainy) did then abound; as lute-ſtrings, which are made likewiſe of the membraneous parts of guts, ſtrongly wreathed, are known to ſwell ſo much oftentimes, as to break in rainy and wet weather. Which conjecture is the more to be regarded, becauſe congruouſly unto it one of the company having a little warmed the bladder, found it then lighter than the oppoſite weight. But this muſt be looked upon as a bare conjecture, till we can gain time to make farther trials about it. In the mean while, we ſhall

* *Aëre frigido exiſtente tardius moventur Automata quam aëre calido, adeo quidem ut Automaton, quod Belgæ in Nova Zembla agentes in ædibus ſuis collocaverunt, omnino motu ceſſaverit etſi multo majus pondus ei addidiſſent quam antea ferre ſolebat.* Varenius Geog. General. Lib. III. Propo. 7. pag. 648.

ſhall add, that without removing the ſcales or the cover of the receiver, we again cauſed the air to be drawn out, (the weather continuing very moiſt) but found not any manifeſt alteration in the balance; whether becauſe the æquilibrium was too far loſt to let a ſmall change appear, we determine not.

BUT to make the experiment with a body leſs apt to be altered by the temperature of the air, than was the bladder; we brought the ſcales again to an æquilibrium with two weights, whereof the one was of lead, the other of cork. And having evacuated the receiver, we obſerved, that both upon the exſuction, and after the return of the air, the cork did manifeſtly preponderate, and much more, a while after the air had been let in again, than whilſt it was kept out. Wherefore, in the room of the cork, we ſubſtituted a piece of charcoal, as leſs likely to imbibe any moiſture from the air, but the event proved much the ſame with that newly related: ſo that this experiment ſeems more liable to caſualties than any, excepting one we have made in our engine. And as it is difficult to prevent them, ſo it ſeems not very eaſy to diſcover the cauſes of them, whereof we ſhall therefore at preſent forbear mentioning our conjectures.

EXPERIMENT XXXV.

SOME learned Mathematicians have of late ingeniouſly endeavoured to reduce filtres to ſiphons; but ſtill the true cauſe of the aſcenſion of water, and other liquors both in ſiphons and in filtration, needing (for aught we have yet found) a clearer diſcovery and explication, we were deſirous to try, whether or no the preſſure of the air might reaſonably be ſuppoſed to have either the principal, or at leaſt a conſiderable intereſt in the raiſing of thoſe liquors. But becauſe we found, that we could not yet ſo evacuate our receiver, but that the remaining air, though but little in compariſon of the exhauſted, would be able to impel the water to a greater height than is uſual in ordinary filtrations; we reſolved, inſtead of a liſt of cotton, or the like filtre, to make uſe of a ſiphon of glaſs, delineated in the third figure; conſiſting of three pieces, two ſtreight, and the third crooked to join them together; whoſe junctures were diligently cloſed, that no air might find entrance at them. One of the legs of this ſiphon was (as it ſhould be) ſomewhat longer than the other, and was pervious at the bottom of it only, by a hole almoſt as ſlender as a hair, that the water might but very leiſurely drop out of it, leſt it ſhould all run out before the experiment were compleated. The other and ſhorter leg of the ſiphon was quite open at the end, and the ſame wideneſs with the reſt of the pipe, whoſe bore was about a quarter of an inch. The whole ſiphon made up of theſe ſeveral pieces put together was deſigned to be about a foot and a half long; that the remaining air, when the veſſel was exhauſted after the wonted manner, might not be able to impel the water to the top of the ſiphon; which being inverted, was filled with water, and of which the ſhorter leg being let down two or three inches deep into a glaſs veſſel full of water, and the upper parts of it being faſtened to the inſide of the cover of the receiver, we proceeded to cloſe firſt, and then to empty the veſſel.

THE effect of the trial was this, that till a pretty quantity of air had been drawn out, the water dropped freely out at the lower end of the lower leg of the ſiphon, as if the experiment had been performed in the free air. But afterwards, the bubbles (as had been apprehended) began to diſcloſe themſelves in the water, and aſcending to the top of the ſiphon, imbodied themſelves there into one, which was augmented by little and little, by the riſing of other bubbles, that from time to time broke into it, but much more by its own dilatation, which increaſed proportionably to the exſuction, that was made of the air out of the receiver. So that at length the water in the ſhorter leg of the ſiphon was reduced, partly by the extraction of the ambient air, and partly by the expanſion of the great bubble at the upper part of the ſiphon, to be but about a foot high, if ſo much; whereby it came to paſs, that the courſe of the water in the ſiphon was interrupted, and that, which remained in the longer leg of it, continued ſuſpended there without dropping any longer. But upon the turning of the ſtop-cock, the outward air (being let into the receiver) got into the ſiphon, by the little hole, at which the water formerly dropped out; and traverſing all the incumbent cylinder of water, in the form of bubbles, joined it ſelf with that air, that before poſſeſſed the top of the ſiphon.

TO prevent the inconveniences ariſing from theſe bubbles, two glaſs pipes, like the former, were ſo placed, as to terminate together in the midſt of the belly of a glaſs phial, into whoſe neck they were carefully faſtened with cement; and then both the phial and the pipes being, (which was not done without difficulty) totally filled with water, the ſiphon deſcribed in the fifth figure was placed with its ſhorter leg in the glaſs of water, as formerly: and the experiment being proſecuted after the ſame manner, much more air than formerly was drawn out, before the bubbles, diſcloſing themſelves in the water, were able to diſturb the experiment; becauſe that in the capacity of the phial there was room enough for them to ſtretch themſelves, without depreſſing the water below the ends of the pipes: and during this time, the water continued to drop out of the propending leg of the ſiphon. But at length the receiver being very much emptied, the paſſage of the water through the ſiphon ceaſed, the upper ends of the pipes beginning to appear a little above the remaining water in the phial, whoſe dilated air appeared likewiſe to preſs down the water in the pipes, and fill the upper part of them.

AND hereby the continuity of the water, and ſo the experiment itſelf being interrupted, we were invited to let in the air again, which, according

according to its various proportions of preſſure to that of the air in the phial and the pipes, did for a good while exhibit a pleaſing variety of phænomena, which we have not now the leiſure to recite. And though upon the whole matter there ſeemed little or no cauſe to doubt, but that, if the bubbles had not diſturbed the experiment, it would manifeſtly enough have appeared, that the courſe of water through ſiphons depends upon the preſſure of the air; yet we reſolved, at our next leiſure and conveniency, to try the experiment again, with a quantity of water before freed from bubbles by the help of the ſame engine.

THIS occaſion I have had to take notice of ſiphons, puts me in mind of an odd kind of ſiphon, that I cauſed to be made a pretty while ago; and which hath been ſince, by an ingenious man of your acquaintance, communicated to divers others. The occaſion was this: an eminent Mathematician told me one day, that ſome inquiſitive Frenchmen (whoſe names I know not) had obſerved, that in caſe one end of a ſlender and perforated pipe of glaſs be dipped in water, the liquor will aſcend to ſome height in the pipe, though held perpendicular to the plain of the water. And, to ſatisfy me, that he miſ-related not the experiment, he ſoon after brought two or three ſmall pipes of glaſs, which gave me the opportunity of trying it; though I had the leſs reaſon to diſtruſt it, becauſe I remember I had often, in the long and ſlender pipes of ſome weather-glaſſes, which I had cauſed to be made after a ſomewhat peculiar faſhion, taken notice of the like aſcenſion of the liquor, though (preſuming it might be caſual) I had made but little reflection upon it. But after this trial, beginning to ſuppoſe, that though the water in theſe pipes, that were brought me, riſe not above a quarter of an inch, (if near ſo high) yet, if the pipes were made ſlender enough, the water might riſe to a very much greater height; I cauſed ſeveral of them to be, by a dexterous hand, drawn out at the flame of a lamp, in one of which, that was almoſt incredibly ſlender, we found, that the water aſcended (as it were of it ſelf) five inches by meaſure, to the no ſmall wonder of ſome famous Mathematicians, who were ſpectators of ſome of theſe experiments. And this height the water reached to, though the pipe were held in as erected a poſture as we could; for if it were inclined, the water would fill a greater part of it, though not riſe higher in it. And we alſo found, that when the inſide of the pipe was wetted beforehand, the water would riſe much better than otherways. But we cauſed not all our ſlender pipes to be made ſtreight, but ſome of them crooked, like ſiphons: and having immerſed the ſhorter leg of one of theſe into a glaſs, that held ſome fair water, we found, as we expected, that the water ariſing to the top of the ſiphon, though that were high enough, did of it ſelf run down the longer leg, and continue running like an ordinary ſiphon. The cauſe of this aſcenſion of the water appeared to all that were preſent ſo difficult, that I muſt not ſtay to enumerate the various conjectures that were made at it, much leſs to examine them; eſpecially having nothing but bare conjectures to ſubſtitute in the room of thoſe I do not approve. We tried indeed, by conveying a very ſlender pipe and a ſmall veſſel of water into our engine, whether or no the exſuction of the ambient air would aſſiſt us to find the cauſe of the aſcenſion we have been ſpeaking of: but though we employed red wine inſtead of water, yet we could ſcarce certainly perceive thorough ſo much glaſs, as was interpoſed betwixt our eyes and the liquor, what happened in a pipe ſo ſlender, that the redneſs of the wine was ſcarce ſenſible in it. But, as far as we could diſcern, there happened no great alteration to the liquor; which ſeemed the leſs ſtrange, becauſe the ſpring of that air, that might depreſs the water in the pipe, was equally debilitated with that, which remained to preſs upon the ſurface of the water in the little glaſs. Wherefore, in favour of his ingenious conjecture, who aſcribed the phænomenon under conſideration to the greater preſſure made upon the water by the air without the pipe, than by that within it, (where ſo much of the water, conſiſting perhaps of corpuſcles more pliant to the internal ſurfaces of the air, was contiguous to the glaſs) it was ſhown, that in caſe the little glaſs-veſſel, that held the water, of which a part aſcended into the ſlender pipe, were ſo cloſed, that a man might with his mouth ſuck the air out of it, the water would immediately ſubſide in the ſmall pipe. And this would indeed infer, that it aſcended before only by the preſſure of the incumbent air; but that it may (how juſtly I know not) be objected, that peradventure this would not happen, in caſe the upper end of the pipe were in a vacuum; and that it is very probable the water may ſubſide, not becauſe the preſſure of the internal air is taken off by exſuction, but by reaſon of the ſpring of the external air, which impels the water, it finds in its way to the cavity deſerted by the other air, and would as well impel the ſame water upwards, as make it ſubſide, if it were not for the accidental poſture of the glaſſes. However, having not now leiſure to examine any farther this matter, I ſhall only mind your Lordſhip, that if you will proſecute this ſpeculation, it will be pertinent to find out likewiſe, why the ſurface of water (as is manifeſt in pipes) uſeth to be concave, being depreſſed in the middle, and higher on every ſide: And why in quickſilver, on the contrary, not only the ſurface is wont to be very convex, or ſwelling, in the middle; but if you dip the end of a ſlender pipe in it, the ſurface of the liquor (as it is called) will be lower within the pipe, than without. Which phænomena, whether, and how far, they may be deduced from the figure of the mercurial corpuſcles, and the ſhape of the ſpringy particles of the air, I willingly leave to be conſidered.

EXPERIMENT XXXVI.

SEVERAL ways we have met with propoſed, partly by the excellent *Galileo*, and partly by other ingenious writers, to manifeſt, that the air is not devoid of weight; ſome of theſe

theſe require the previous abſence of the air to be weighed; and others, the violent condenſation of it. But if we could lift a pair of ſcales above the atmoſphere, or place them in a vacuum, we might there weigh a parcel of air it ſelf, as here we do other bodies in the air, becauſe it would there be heavier than that which ſurrounds it, as are groſſer bodies we commonly weigh, than the medium or ambient air. Wherefore, though we have above declined to affirm, that our receiver, when emptied, deſerves the name of a true vacuum; and though we cannot yet perfectly free it from air it ſelf; yet we thought fit to try how far the air would manifeſt its gravity in ſo thin a medium, as we could make in our receiver, by evacuating it. We cauſed then to be blown at the flame of a lamp a glaſs bubble of about the bigneſs of a ſmall hen-egg, and of an oval form, ſave that at one end there was drawn out an exceeding ſlender pipe, that the bubble might be ſealed up, with as little rarefaction as might be of the air included in the great or oval cavity of it. This glaſs being ſealed, was faſtened to one of the ſcales of the exact pair of balances formerly mentioned; and being counterpoiſed with a weight of lead, was conveyed into the receiver, and cloſed up in it. The beam appearing to continue horizontal, the pump was ſet on work; and there ſcarce paſt above two or three exſuctions of the air, before the balance loſt its æquilibrium, and began to incline to that ſide on which the bubble was; which, as the air was farther and farther drawn out, did manifeſtly more and more preponderate, till he that pumped began to grow weary of his imployment: after which the air being leiſurely let in again, the ſcales by degrees returned to their former æquilibrium. After that we took them out, and caſting into that ſcale to which the lead belonged three quarters of a grain, we conveyed the balance into the receiver, which being cloſed up, and exhauſted as before, we obſerved, that as the air was drawn out more and more, ſo the glaſs bubble came nearer and nearer to an æquilibrium with the other weight, till at length the beam was drawn to hang horizontal; which (as we had found by another trial) we could not bring it to do, when a quarter of a grain more was added to the ſcale, to which the lead belonged: though it ſeemed queſtionleſs, that if we could have perfectly emptied the receiver of the contained air, that included in the bubble would have weighed above a grain, notwithſtanding its having been probably ſomewhat rarefied by the flame, by the help of which the bubble was ſealed up. Let us add, that on the regreſs of the excluded air, the lead, and the weight caſt into the ſame ſcale, did again very much preponderate.

WE likewiſe conveyed into the receiver the ſame bubble, opened at the end of the ſlender pipe above mentioned; but having drawn out the air, after the accuſtomed manner, we found not, as before, the bubble to out-weigh the oppoſite lead; ſo that by the help of our engine we can weigh the air, as we weigh other bodies, in its natural or ordinary conſiſtence, without at all condenſing it: nay, which is remarkable, having conveyed a lamb's bladder about half full of air into the receiver, we obſerved, that though upon the drawing out of the ambient air, the impriſoned air ſo expanded itſelf, as to diſtend the bladder ſo, as to ſeem ready to break it; yet this rarefied air did manifeſtly depreſs the ſcale, whereunto it was annexed.

ANOTHER thing we muſt not forget to mention, that happened to us, whilſt we were making trials concerning the weight of the air; namely, that having once cauſed the pump to be ſomewhat obſtinately plied, to diſcover the better what may be expected from the thinneſs of the medium in this experiment; the impriſoned air broke its brittle priſon, and throwing the greateſt part of it againſt the ſide of the receiver, daſhed it againſt that thick glaſs into a multitude of pieces. Which accident I mention, partly, that it may confirm what we delivered in our reflexions upon the firſt experiment, where we conſidered what would probably be done by the ſpring of the air impriſoned in ſuch glaſſes, in caſe the balancing preſſure of the ambient air were withdrawn; and partly, that we may thence diſcern of how cloſe a texture glaſs is, ſince ſo very thin a film of glaſs (if I may ſo call it) proved ſo impervious to the air, that it could not get away through the pores, but was forced to break the glaſs in pieces to free it ſelf; and this, notwithſtanding the time and advantage it had to try to get out at the pores. And this I mention, that neither our experiments, nor thoſe of divers learned men, might receive any prejudice from an experiment, which I happened to make divers years ago, and which, having been ſo much taken notice of by curious men, may be drawn to countenance their erroneous opinion, who would fain perſuade us, that glaſs is penetrable by air properly ſo called. Our experiment was briefly this: We were diſtilling a certain ſubſtance, that much abounded with ſubtile ſpirits and volatile ſalt, in a ſtrong earthen veſſel of an unuſual ſhape, to which was luted a large receiver, made of the coarſer ſort of glaſs (which the trades-men are wont to call green glaſs;) but in our abſence, the fire, though it were to be very ſtrong, was, by the negligence or miſtake of thoſe we appointed to attend it, ſo exceſſively increaſed, that when we came back to the furnace, we found the ſpirituous and ſaline corpuſcles poured out (if I may ſo call it) ſo hot, and ſo copiouſly into the receiver, that they made it all opacous, and more likely to fly in pieces, than fit to be touched. Yet, being curious to obſerve the effects of a diſtillation, proſecuted with ſo intenſe and unuſual a degree of heat, we ventured to come near; and obſerved, among other things, that on the outſide of the receiver, at a great diſtance from the juncture, there was ſettled a round whitiſh ſpot or two, which at firſt we thought might be ſome ſtain upon the glaſs; but after, finding it to be in divers qualities like the oil and ſalt of the concrete we were diſtilling, we began to ſuſpect, that the moſt ſubtile and fugitive parts of the impetuouſly aſcending ſteams had penetrated the ſubſtance

(as they ſpeak) of the glaſs, and by the cold of the ambient air were condenſed on the ſurface of it. And though we were very backward to credit this ſuſpicion, and therefore called in an ingenious perſon or two, both to aſſiſt us in the obſervation, and have witneſs of its event, we continued a while longer to watch the eſcape of ſuch unctuous fumes; and upon the whole matter unanimouſly concluded, that (all things conſidered) the ſubtile parts of the diſtilled matter being violently agitated by the exceſſive heat, that paſſed through the pores of the glaſs, widened by the ſame heat. But this having never happened but once in any of the diſtillations we have either made or ſeen, though theſe be not a few, it is much more reaſonable to ſuppoſe, that the perviouſneſs of our receiver to a body much more ſubtile than air proceeded partly from the looſer texture of that particular parcel of glaſs the receiver was made of, (for experience hath taught us, that all glaſs is not of the ſame compactneſs and ſolidity) and partly from the enormous heat, which, together with the vehement agitation of the penetrant ſpirits, opened the pores of the glaſs; than to imagine that ſuch a ſubſtance as air ſhould be able to permeate the body of glaſs, contrary to the teſtimony of a thouſand chymical and mechanical experiments, and of many of thoſe made in our engine, eſpecially that newly recited: nay, by our fifth experiment it appears, that a thin bladder will not at its pores give paſſage even to rarefied air. And on this occaſion we will annex an experiment, which hath made ſome of thoſe we have acquainted with it doubt, whether the corpuſcles of the air be not leſs ſubtile than thoſe of water.

BUT without examining here the reaſonableneſs of that doubt, we will proceed to recite the experiment it ſelf, which ſeems to teach, that though air, when ſufficiently compreſſed, may perchance get entrance into narrower holes and crannies than water; yet unleſs the air be forced in at ſuch very little holes, it will not get in at them, though they may be big enough to let water paſs through them.

THE experiment then was this: I took a fair glaſs ſiphon, the lower end of whoſe longeſt leg was drawn by degrees to ſuch a ſlenderneſs, that the orifice, at which the water was to fall out, would hardly admit a very ſmall pin. This ſiphon being inverted, the matter was ſo ordered, that a little bubble of air was intercepted in the ſlendereſt part of the ſiphon, betwixt the little hole newly mentioned and the incumbent water; upon which it came to paſs, that the air being not to be forced through ſo narrow a paſſage, by ſo light a cylinder of water, (though amounting to the length of divers inches,) as leaned upon it, hindered the farther efflux of the water, as long as I pleaſed to let it ſtay in that narrow place: whereas, when by blowing a little at the wider end of the ſiphon, that little parcel of air was forced out with ſome water, the remaining water, that before continued ſuſpended, began freely to drop down again as formerly. And if you take a glaſs pipe, whether it be in the form of a ſiphon, or no, that being for the moſt part of the thickneſs of a man's finger, is yet towards one end ſo ſlender, as to terminate in a hole almoſt as ſmall as a horſe-hair; and if you fill this pipe with water, you will find that liquor to drop down freely enough thorough the ſlender extreme: but if you then invert the pipe, you will find, that the air will not eaſily get in at the ſame hole, through which the water paſſed. For in the ſharp end of the pipe, ſome inches of water will remain ſuſpended, which, it is probable, would not happen, if the air could get in to ſucceed it; ſince if the hole were a little wider, the water would immediately ſubſide. And though it be true, that if the pipe be of the length of many inches, a great part of the water will run down at the wider orifice; yet that ſeems to happen for ſome other reaſon, than becauſe the air ſucceeds it at the upper and narrow orifice, ſince all the ſlender part of the pipe, and perhaps ſome inches more, will continue full of water.

AND on this occaſion I remember, that whereas it appears by our fifth experiment, that the aërial corpuſcles (except perhaps ſome, that are extraordinary fine) will not paſs thorough the pores of a lamb's bladder, yet particles of water will, as we have long ſince obſerved, and as may be eaſily tried, by very cloſely tying a little alcalizate ſalt (we uſed the calx of tartar made with nitre) in a fine bladder, and dipping the lower end of the bladder in water: for if you hold it there for a competent while, you will find, that there will ſtrain thorough the pores of the bladder water enough to diſſolve the ſalt into a liquor.

BUT I ſee I am ſlipped into a digreſſion; wherefore I will not examine, whether the experiment I have related proceeded from hence, that the ſpringy texture of the corpuſcles of the air makes them leſs apt to yield and accommodate themſelves eaſily to the narrow pores of bodies than the more flexible particles of water; or whether it may more probably be aſcribed to ſome other cauſe. Nor will I ſtay to conſider, how far we may hence be aſſiſted to gueſs at the cauſe of the aſcenſion of water in the ſlender pipes and ſiphons formerly mentioned; but will return to our bubble, and take notice, that we thought fit alſo to endeavour to meaſure the capacity of the bubble we had made uſe of, by filling it with water, that we might the better know how much water anſwered in weight to $\frac{3}{4}$ of a grain of air. But notwithſtanding all the diligence, that was uſed to preſerve ſo brittle a veſſel, it broke before we could perfect that we were about, and we were not then provided of another bubble fit for our turn.

THE haſte I was in, my Lord, when I ſent away the laſt ſheet, made me forget to take notice to you of a problem, that occurred to my thoughts, upon the occaſion of the ſlow breaking of the glaſs bubble in our evacuated receiver. For it may ſeem ſtrange, ſince by our ſixth experiment it appears, that the air, when permitted, will by its own internal ſpring expand itſelf twice as much as *Merſennus* was

able to expand it, by the heat even of a candent æolipile; yet the elater of the air was ſcarce able to break a very thin glaſs bubble, and utterly unable to break one ſomewhat thicker, within whoſe cavity it was impriſoned. Whereas air penned up and agitated by heat is able to perform ſo much more conſiderable effects, that (not to mention thoſe of rarefaction, that are more obvious) the learned Jeſuit *Cabæus* (he that writ of the load-ſtone) relates, that he ſaw a marble pillar (ſo vaſt, that three men together with diſplayed arms could not imbrace it, and that 1000 yoke of oxen, drawing it ſeveral ways with all their ſtrength, could not have torn it aſunder) quite broken off in the midſt, by reaſon of ſome wood, which happening to be burnt juſt by the pillar, the heat proceeding from the neighbouring fir ſo rarefied ſome air or ſpirituous matter, which was ſhut up in the cavities of the marble, that it broke through the ſolid body of the ſtone to obtain room to expand itſelf.

P. Nichol. Cab. lib. 4. Meteor. Ariſtot.

I REMEMBER I have taken notice, that probably the reaſon, why the included air did not break the hermetically ſealed bubbles, that remained intire in our emptied receiver, was, that the air, being ſomething rarefied by the flame imployed to cloſe the glaſs, its ſpring, upon the receſs of the heat, grew weaker than before. But though we reject not that gueſs, yet it will not in the preſent caſe ſerve the turn; becauſe that much ſmaller glaſs bubbles exactly cloſed will, by the included air (though agitated by the heat of a very moderate fire) be made to fly in pieces. Whether we may be aſſiſted to ſolve this problem, by conſidering, that the heat doth from within vehemently agitate the corpuſcles of the air, and add its aſſiſtance to the ſpring they had before, I ſhall not now examine; ſince I here but propoſe a problem, and that chiefly, that by this memorable ſtory of *Cabæus* notice may be taken of the prodigious power of rarefaction, which hereby appears capable of performing ſtranger things, than any of our experiments have hitherto aſcribed to it.

WE ſhould hence, my Lord, immediately proceed to the next experiment, but that we think it fit, on this occaſion, to acquaint you with what ſome former trials (though not made in our engine) have taught us, concerning what we would have diſcovered by the newly mentioned bubble that broke. And this the rather, becauſe (a great part of this letter ſuppoſing the gravity of the air) it will not be impertinent to determine more particularly than hitherto we have done, what gravity we aſcribe to it.

WE took then an æolipile made of copper, weighing ſix ounces, five drachms, and eight and forty grains: this being made as hot as we durſt make it, (for fear of melting the metal, or at leaſt the ſoder) was removed from the fire, and immediately ſtopped with hard wax, that no air at all might get in at the little hole, wont to be left in æolipiles for the fumes to iſſue out at: then the æolipile being ſuffered leiſurely to cool, was again weighed together with the wax that ſtopt it, and was found to weigh (by reaſon of the additional weight of the wax) ſix ounces, ſix drachms, and 39 grains. Laſtly, the wax being perforated without taking any of it out of the ſcale, the external air was ſuffered to ruſh in (which it did with ſome noiſe) and then the æolipile and wax, being again weighed, amounted to ſix ounces, ſix drachms, and 50 grains. So that the æolipile freed, as far as our fire could free it, from its air, weighed leſs than itſelf when repleniſhed with air, full eleven grains: that is, the air containable within the cavity of the æolipile amounted to eleven grains and ſomewhat more; I ſay ſomewhat more, becauſe of the particles of air, that were not driven by the fire out of the æolipile. And by the way (if there be no miſtake in the obſervations of the diligent *Merſennus)* it may ſeem ſtrange, that it ſhould ſo much differ from 2 or 3 of ours; in none of which we could rarefy the air in our æolipile (though made red-hot almoſt all over, and ſo immediately plunged into cold water) to half that degree, which he mentions, namely to 70 times its natural extent, unleſs it were, that the æolipile he employed was able to ſuſtain a more vehement heat than ours, (which yet we kept in ſo great an one, that once the ſoder melting, it fell aſunder into the two hemiſpheres it conſiſts of.)

THE forementioned way of weighing the air by the help of an æolipile ſeems ſomewhat more exact than that, which *Merſennus* uſed, in that in ours the æolipile was not weighed till it was cold; whereas in his, being weighed red-hot, it is ſubject to loſe of its ſubſtance in the cooling, for (as we have elſewhere noted on another occaſion) copper heated red-hot is wont in the cooling to throw off little thin ſcales in ſuch plenty, that having purpoſely watched a copper æolipile during its refrigeration, we have ſeen the place round about it almoſt covered with thoſe little ſcales it had every way ſcattered: which, however they amount not to much, ought not to be overlooked, when it is ſo light a body as air that is to be weighed. We will not examine, whether the æolipile in cooling may not receive ſome little increment of weight, either from the vapid or ſaline ſteams, that wander up and down in the air; but we will rather mention, that (for the greater exactneſs) we employed to weigh our æolipile, both when filled only with air and when repleniſhed with water, a pair of ſcales, that would turn (as they ſpeak) with the fourth part of a grain.

As to the proportion of weight betwixt air and water, ſome learned men have attempted it by ways ſo unaccurate that they ſeem to have much miſtaken it. For (not to mention the improbable accounts of *Kepler* and others) the learned and diligent *Ricciolus*, having purpoſely endeavoured to inveſtigate this proportion by means of a thin bladder, eſtimates the weight of the air to that of the water to be as one to ten thouſand, or thereabouts. And indeed I remember, that having formerly, on a certain occaſion, weighed a large bladder full of air, and found it, when the air was all ſqueezed out, to have contained fourteen grains

of

of air; I found the ſame bladder afterwards filled with water to contain very near 14 pound of that liquor: according to which account, the proportion of air to water was almoſt as a grain to a pound, that is, as 1 to above 7600. To this we may add, that on the other ſide, *Galileo* himſelf uſing another, (but an unaccurate way too,) defined the air to be in weight to water but as one to 4 hundred. But the way formerly propoſed of weighing the air by an æolipile ſeems by great odds more exact; and (as far as we could gueſs) ſeemed to agree well enough with the experiment made in our receiver. Wherefore it will be beſt to truſt our æolipile in the inquiry we are about. And according to our obſervations, the water it contained amounting to one and twenty ounces and an half, and as much air as was requiſite to fill it weighing eleven grains, the proportion in gravity of air to water of the ſame bulk will be as one to 938. And though we could not fill the æolipile with water ſo exactly as we would, yet in regard we could not neither as perfectly as we would drive the air out of it by heat, we think the proportion may well enough hold: but thoſe, that are delighted with round numbers (as the phraſe is) will not be much miſtaken, if they reckon water to be near a thouſand times heavier than air. And (for farther proof, that we have made the proportion betwixt theſe two bodies rather greater than leſſer than indeed it is, and alſo to confirm our former obſervation of the weight of the air) we will add, that, having another time put ſome water into the æolipile before we ſet it on the fire, that the copious vapours of the rarefied liquor might the better drive out the air, we found, upon trial carefully made, that when the æolipile was refrigerated, and the included vapours were by the cold turned again into water, (which could not have happened to the air, that the preceding ſteams expelled) the air, when it was let in, increaſed the weight of the æolipile as much as before, namely, eleven grains; though there were already in it twelve drachms and a half, beſides a couple of grains of water, which remained of that we had formerly put into it to drive out the air.

Merſennus indeed tells us, that by his account air is in weight to water, as 1 to 1356. And adds, that we may, without any danger, believe, that the gravity of water to that of air of a like bulk is not leſs than of 1300 to 1. And conſequently, that the quantity of air to a quantity of water equiponderant thereto is as 1300 to 1. But why we ſhould relinquiſh our own carefully repeated trials, I ſee not. Yet I am unwilling to reject thoſe of ſo accurate and uſeful a writer: and therefore ſhall propoſe a way of reconciling our differing obſervations, by preſenting, that the diſcrepance between them may probably ariſe from the differing conſiſtence of the air at *London* and at *Paris:* for our air being more cold and moiſt than that which your Lordſhip now breathes, may be ſuppoſed alſo to be a fourth or fifth part more heavy. I leave it to be conſidered, whether it be of any moment, that our obſervations were made in the midſt of winter; whereas his were perhaps made in ſome warmer time of the year. But I think it were not amiſs, that, by the method formerly propoſed, the gravity of the air were obſerved both in ſeveral countries, and in the ſame country, in the ſeveral ſeaſons of the year and differing temperatures of the weather. And I would give ſomething of value to know the weight of ſuch an æolipile as ours full of air, in the midſt of winter in *Nova Zembla*; if that be true, which we formerly took notice of, namely, that the Hollanders, who wintered there, found that air ſo thick, that their clock would not go.

IF your Lordſhip ſhould now aſk me, if I could not by the help of theſe, and our other obſervations, decide the controverſies of our modern mathematicians about the height of the air or atmoſphere, by determining how high it doth indeed reach; I ſhould anſwer, that though it ſeems eaſy enough to ſhew, that divers famous and applauded writers have been miſtaken in aſſigning the height of the atmoſphere, yet it ſeems very difficult preciſely to define of what height it is. And becauſe we have hitherto but lightly touched upon a matter of ſuch importance, we preſume it will not be thought impertinent, upon this occaſion, to annex ſomething towards the elucidation of it.

WHAT we have already tried and newly ſet down allows us to take it for granted, that (at leaſt about *London*) the proportion of gravity betwixt water and air, of equal bulk is as of a thouſand to one.

THE next thing therefore, that we are to inquire after, in order to our preſent deſign, is the difference in weight betwixt water and quickſilver: and though this hath been defined already by the illuſtrious *Verulam*, and ſome other inquiſitive perſons, that have compared the weight of ſeveral bodies, and caſt their obſervations into tables, yet we ſhall not ſcruple to annex our own trials about it; partly, becauſe we find authors conſiderably to diſagree; partly, becauſe we uſed exacter ſcales, and a ſomewhat more wary method than others ſeem to have done; and partly alſo, becauſe having proſecuted our inquiry by two or three ſeveral ways, the ſmall difference between the events may aſſure us, that we were not much miſtaken.

WE took then a glaſs pipe, of the form of an inverted ſiphon, whoſe ſhape is delineated in the ſixteenth figure; and pouring into it a quantity of quickſilver, we held it ſo, that the ſuperficies of the liquor, both in the longer and ſhorter leg, lay in a horizontal line, denoted in the ſcheme by the pricked line E F: then pouring water into the longer leg of the ſiphon, till that was almoſt filled, we obſerved the ſurface of the quickſilver in that leg to be, by the weight of the water, depreſſed, as from E to B; and in the ſhorter leg, to be as much impelled upwards as from F to C. Whereupon having formerly ſtuck marks, as well at the point B, as at the oppoſite point D, we meaſured both the diſtance D C to have the height of the cylinder of quickſilver, which was raiſed above the point D (level with the ſurface of the

the quickſilver in the other leg) by the weight of the water, and the diſtance B A, which gave us the height of the cylinder of water. So that the diſtance D C amounting to $2\frac{13}{54}$ inches, and the height of the water amounting to $30\frac{45}{54}$ inches; and the whole numbers on both ſides, with the annexed fractions, being reduced to improper fractions of the ſame denomination, the proportion appeared to be (the denominators being left out as equal on both ſides) as 121 to 1665; or by reduction, as one to $\frac{92}{121}$.

BESIDES this unuſual way of determining the gravity of ſome things, we meaſured the proportion betwixt quickſilver and water, by the help of ſo exact a balance, as loſeth its æquilibrium by the hundredth part of a grain. But becauſe there is wont to be committed an overſight in weighing quickſilver and water, eſpecially if the orifice of the veſſel wherein they are put be any thing wide, in regard that men heed not that the ſurface of water in veſſels will be concave, but that of quickſilver notably convex or protuberant; to avoid this uſual overſight (I ſay) we made uſe of a glaſs bubble, blown very thin at the flame of a lamp, that it might not be too heavy for the balance, and terminating in a very ſlender neck wherein the concavity or convexity of a liquor could not be conſiderable; this glaſs weighing $23\frac{1}{2}$ grains, we filled almoſt with quickſilver, and faſtening a mark over againſt the middle of the protuberant ſuperficies as near as our eyes could judge, we found that the quickſilver alone weighed $299\frac{7}{12}$ grains; then the quickſilver being poured out, and the ſame glaſs being filled as full of common water, we found the liquor to weigh $21\frac{7}{8}$ grains. Whereby it appeared the weight of water to quickſilver, is as one to $13\frac{19}{24}$; though our illuſtrious *Verulam* (queſtionleſs not for want of judgment or care, but of exact inſtruments) makes the proportion betwixt thoſe two liquors to be greater than of 1 to 17. And to add, that upon the bye, ſince quickſilver and well rectified ſpirit of wine, are (how juſtly I ſay not) accounted, the one the heavieſt, and the other the lighteſt of liquors; we thought to fill the ſame glaſs, and with the ſame ſcales to obſerve the difference betwixt them, which we found to be as of 1 to $16\frac{641}{1084}$; whereby it appeared, that the difference betwixt ſpirit of wine, that may be made to burn all away, (ſuch as was ours) and common water, is as betwixt 1 and $1\frac{44}{271}$.

WE might here take occaſion to admire, that though water (as appeared by the experiment formerly mentioned of the pewter veſſel) ſeems not capable of any conſiderable condenſation, and ſeems not to have interſperſed into it any ſtore of air; yet quickſilver, of no greater bulk than water, ſhould weigh near fourteen times as much. But having only pointed at this as a thing worthy of conſideration, we will proceed in our inquiry after the height of the atmoſphere: and to avoid the trouble of fractions, we will aſſume, that quickſilver is fourteen times as heavy as water, ſince it wants ſo little of being ſo.

WHEREFORE, having now given us the proportion of air to water, and water to quickſilver, it will be very eaſy to find the proportion betwixt air and quickſilver, in caſe we will ſuppoſe the atmoſphere to be uniformly of ſuch a conſiſtence as the air we weighed here below. For ſince our engine hath ſufficiently manifeſted that it is the æquilibrium with the external air, that in the Torricellian experiment keeps the quickſilver from ſubſiding; and ſince, by our accurate experiment formerly mentioned, it appears that a cylinder of mercury, able to balance a cylinder of the whole atmoſphere, amounted to near about thirty inches; and ſince, conſequently we may aſſume the proportion of quickſilver to air to be as fourteen thouſand to one; it will follow, that a cylinder of air, capable to maintain an æquilibrium, with a mercurial cylinder of two feet and an half in height, muſt amount to 35000 feet of our Engliſh meaſure; and conſequently (reckoning five feet to a geometrical pace, and one thouſand ſuch paces to a mile) to ſeven full miles.

BUT this (as we lately intimated) proceeds upon the ſuppoſition, that the air is every where of the ſame conſiſtence that we found it near the ſurface of the earth; but that cannot with any ſafety be concluded, not only for the reaſon I find to have been taken notice of by the ancients, and thus expreſſed in *Seneca*: *Omnis aër* (ſays he) *quo propior eſt terris, hoc craſſior; quemadmodum in aqua & in omni humore fæx ima eſt, ita in aëre ſpiſſiſſima quæque deſidunt.* Senec. *Nat. quæſt. Lib. 4. cap.* 10. But much more, becauſe the ſpringy texture of the aërial corpuſcles makes them capable of a very great compreſſion, which the weight of the incumbent part of the atmoſphere is very ſufficient to give thoſe that be undermoſt and near the ſurface of the earth. And if we recall to mind thoſe former experiments, whereby we have manifeſted that air, much rarefied without heat, may eaſily admit a farther rarefaction from heat, and that the air, even without being expanded by heat, is capable of being rarefied to above one hundred and fifty times the extent it uſually poſſeſſeth here below; how can it be demonſtrated that the atmoſphere may not, for aught we know, or at leaſt for aught can be determined by our ſtatical and mechanical experiments, riſe to the height of five and twenty German leagues, if not of ſome hundred of common miles?

AND this conjecture it ſelf may appear very injurious to the height whereunto exhalations may aſcend, if we will allow that there was no miſtake in that ſtrange obſervation made at *Toloufe* in a clear night in *Auguſt*, by the diligent Mathematician *Emanuel Magnan*, and thus recorded by *Ricciolus*, for I have not at hand the author's own book: *Vidit* (ſays he) *ab hora undecima poſt meridiem uſque ad mediam noctem lunâ infra horizontem poſitâ, nubeculam quandam lucidam prope meridianum fere uſque ad Zenith diffuſam, quæ conſideratis omnibus non poterat niſi à ſole illuminari; ideoque altior eſſe debuit tota umbra terræ. Addit* (continues *Ricciolus*) *ſimile quid eveniſſe Michaeli Angelo Riccio apud Sabinos verſanti, nempe viro in matheſi eruditiſſimo.* Ricciol. *Almag. Nov. Tom.* 2. *lib.* 10. *ſect.* 6. *prop.* 50. *Ex Magnan. lib.* 1. *Perſpectivæ horariæ prop.* 38.

VARIOUS obſervations made at the feet, tops, and interjacent parts of high mountains, might perchance ſomewhat aſſiſt us to make an eſtimate in what proportion, if in any certain one, the higher air is thicker than the lower, and gueſs at the difform conſiſtence, as to laxity and compactneſs, of the air, at ſeveral diſtances from us. And if the difficulties about the refractions of the celeſtial lights were ſatisfactorily determined, that might alſo much conduce to the placing due limits to the atmoſphere, (whoſe dimenſions thoſe obſervations about refractions ſeem hitherto much to contract.) But for the preſent we dare not pronounce any thing peremptorily concerning the height of it, but leave it to farther inquiry: contenting our ſelves to have manifeſted the miſtake of divers eminent modern writers, who will not allow the atmoſphere to exceed above two or three miles in height (as the famous *Kepler* will not the *Aër refractivus*) and to have rendered a reaſon why in the mention we made in the notes upon the firſt experiment touching the height of the atmoſphere, we ſcrupled not to ſpeak of it, as if it might be many miles high.

EXPERIMENT XXXVII.

WE will now proceed to recite a phænomenon, which, though made amongſt the firſt, we thought fit not to mention till after many others, that we might have the opportunity to obſerve as many circumſtances of it as we could, and ſo preſent your Lordſhip at once, moſt of what we at ſeveral times have taken notice of concerning ſo odd a phænomenon.

OUR engine had not been long finiſhed, when, at the firſt leiſure we could ſteal from our occaſions to make trial of it, we cauſed the air to be pumped out of the receiver; and whilſt I was buſied in entertaining a learned friend that juſt then came to viſit me, an ingenious by-ſtander thought he perceived ſome new kind of light in the receiver, of which giving me haſtily notice, my friend and I preſently obſerved, that when the ſucker was drawn down, immediately upon the turning of the key, there appeared a kind of light in the receiver, almoſt like a faint flaſh of lightning in the day-time, and almoſt as ſuddenly did it appear and vaniſh. Having, not without ſome amazement, obſerved divers of theſe apparitions of light, we took notice that the day was clear, the hour about ten in the morning, that the only window in the room faced the north; and alſo, that by interpoſing a cloak, or any opacous body between the receiver and the window, though the reſt of the room were ſufficiently enlightened, yet the flaſhes did not appear as before, unleſs the opacous body were removed. But not being able on all theſe circumſtances to ground any firm conjecture at the cauſe of this ſurprizing phænomenon, as ſoon as night was come, we made the room very dark; and plying the pump, as in the morning, we could not, though we often tried, find, upon the turning of the key, ſo much as the leaſt glimmering of light; whence we inferred, that the flaſh appearing in the receiver, did not proceed from any new light generated there, but from ſome reflexions of the light of the ſun, or other luminous bodies placed without it; though whence the reflexion ſhould proceed, it poſed us to conjecture.

WHEREFORE the next morning, hoping to inform our ſelves better, we went about to repeat the experiment; but though we could as well as formerly exhauſt the receiver, though the place wherein we made the trial was the very ſame, and though other circumſtances were reſembling; yet we could not diſcover the leaſt appearance of light all that day, nor on divers others, on which trial was again fruitleſly made; nor can we to this very time be ſure a day before-hand that theſe flaſhes will be to be ſeen in our great receiver. Nay, having once found the engine in a good humour (if I may ſo ſpeak) to ſhew this trick, and ſent notice of it to our learned friend Dr. *Wallis*, who expreſſed a great deſire to ſee this phænomenon, though he were not then above a bow-ſhoot off, and made haſte to ſatisfy his curioſity; yet by that time he was come, the thing he came for was no longer to be ſeen: ſo that having vainly endeavoured to exhibit again the phænomenon in his preſence, I began to apprehend what he might think of me, when unexpectedly the engine preſented us a flaſh, and after that a ſecond, and as many more as ſufficed to ſatisfy him that we might very well confidently relate, that we have our ſelves ſeen this phænomenon, though not confidently promiſe to ſhew it others.

AND this unſucceſsfulneſs whereto our experiment is liable, being ſuch, that by all our watchfulneſs and trials we could never reduce it to any certain rules or obſervations, ſince in all conſtitutions of the weather, times of the day, *&c.* it will ſometimes anſwer, and ſometimes diſappoint our expectations; we are much diſcouraged from venturing to frame an hypotheſis to give an account of it: which if the experiment did conſtantly ſucceed, might the more hopefully be attempted, by the help of the following phænomena laid together; ſome of them produced upon trials purpoſely made to examine the validity of the conjectures, other trials had ſuggeſted.

FIRST then we obſerved, that the apparition of light may be made as well by candle-light, as by day-light; and in whatever poſition the candle be held, in reference to the receiver, as on this or that hand of it, above it, beneath it, or any other way, provided the beams of light be not hindered from falling upon the veſſel.

NEXT, we noted that the flaſh appears immediately upon the turning of the key, to let the air out of the receiver into the emptied cylinder, inſomuch that I remember not that when at any time in our great receiver, the ſtop-cock was opened before the cylinder was exhauſted, (whereby it came to paſs that the air did rather deſcend, than ruſh into the cylinder) the often mentioned flaſh appeared to our eyes.

YET, we farther obſerved, that when inſtead of the great receiver we made uſe of a ſmall glaſs, not containing above a pound and a half of water, the phænomenon might be exhibited though the ſtop-cock were open, provided the ſucker were drawn nimbly down.

WE noted too, that when we began to empty the receiver, the appearances of light were much more conſpicuous than towards the latter end, when little air at a time could paſs out of the receiver.

WE obſerved alſo, that when the ſucker had not been long before well oiled, and inſtead of the great receiver, the ſmaller veſſel abovementioned was emptied; we obſerved, I ſay, that then, upon the opening of the ſtop-cock, as the air deſcended out of the glaſs into the emptied cylinder, ſo at the ſame time there aſcended out of the cylinder into the veſſel a certain ſteam, which ſeemed to conſiſt of very little bubbles, or other minute corpuſcles thrown up from the oil, rarefied by the attrition it ſuffered in the cylinder. For at the ſame time that theſe ſteams aſcended into the glaſs, ſome of the ſame kind manifeſtly iſſued out like a little pillar of ſmoke at the orifice of the valve, when that was occaſionally opened. And theſe ſteams frequently enough preſenting themſelves to our view, we found, by expoſing the glaſs to a clear light, that they were wont to play up and down in it, and ſo by their whitiſhneſs to emulate in ſome meaſure the apparition of light.

FOR we likewiſe ſometimes found, by watchful obſervation, that when the flaſh was great, not only at the very inſtant the receiver loſt of its tranſparency, by appearing full of ſome kind of whitiſh ſubſtance; but that for ſome ſhort time after, the ſides of the glaſs continued ſomewhat opacous, and ſeemed to be darkened, as if ſome whitiſh ſteam adhered to the inſide of them.

HE that would render a reaſon of the phænomenon, whereof all theſe are not all the circumſtances, muſt do two things; whereof the one is difficult, and the other little leſs than impoſſible: for he muſt give an account not only whence the appearing whiteneſs proceeds, but wherefore that whiteneſs doth ſometimes appear, and ſometimes not.

FOR our part, we freely confeſs our ſelves at a loſs about rendering a reaſon of the leſs difficult part of the problem: and though your Lordſhip ſhould even preſs us to declare what conjecture it was, that the above-recited circumſtances ſuggeſted to us, we ſhould propoſe the thoughts we then had, no otherwiſe than as bare conjectures.

IN caſe then our phænomenon had conſtantly and uniformly appeared, we ſhould have ſuſpected it to have been produced after ſome ſuch manner as follows:

FIRST, we obſerved that, though that which we ſaw in our receiver ſeemed to be ſome kind of light, yet it was indeed but a whiteneſs which did (as hath already been noted) opacate (as ſome ſpeak) the inſide of the glaſs.

NEXT, we conſidered, that our common air abounds with particles, or little bodies, capable to reflect the beams of light. Of this we might eaſily give divers proofs, but we ſhall name but two: the one, that vulgar obſervation of the motes that appear in multitudes ſwimming up and down in the air, when the ſun-beams ſhooting into a room, or any other ſhady place, diſcover them, though otherwiſe the eye cannot diſtinguiſh them from the reſt of the air; the other proof we will take from what we (and no doubt very many others) have obſerved, touching the illumination of the air in the night. And we particularly remember, that, being at ſome diſtance from *London* one night, that the people, upon a very welcome occaſion, teſtified their joy by numerous bonfires; though, by reaſon of the interpoſition of the houſes, we could not ſee the fires themſelves, yet we could plainly ſee the air all enlightened over and near the city; which argued, that the lucid beams ſhot upwards from the fires, met in the air with corpuſcles opacous enough to reflect them to our eyes.

A THIRD thing that we conſidered, was, that white may be produced (without excluding other ways, or denying inviſible pores in the ſolideſt bodies) when the continuity of a diaphanous body happens to be interrupted by a great number of ſurfaces, which, like ſo many little looking-glaſſes, do confuſedly repreſent a multitude of little and ſeemingly contiguous images of the lucid body. We ſhall not inſiſt on the explanation of this, but refer you for it to what we have ſaid in another paper, (touching colours.) But the inſtances that ſeem to prove it are obvious: for water or whites of eggs beaten to froth, do loſe their tranſparency, and appear white. And having out of one of our leſſer receivers carefully drawn out the air, and ſo ordered it, that the hole by which the water was to get in, was exceeding ſmall, that the liquor might be the more broken in its paſſage thorough it, we obſerved with pleaſure, that the neck being held under water, and the little hole newly mentioned being opened, the water that ruſhed in was ſo broken, and acquired ſuch a multitude of new ſurfaces, that the receiver ſeemed to be full rather of milk than water. We have likewiſe found out, that by heating a lump of cryſtal to a certain degree, and quenching it in fair water, it would be diſcontinued by ſuch a multitude of cracks, (which created new ſurfaces within it) that though it would not fall aſunder, but retain its former ſhape, yet it would loſe its tranſparency, and appear white.

UPON theſe conſiderations, my Lord, and ſome others, it ſeemed not abſurd to imagine, that upon the ruſhing of the air out of the receiver into the emptied cylinder, the air in the receiver being ſuddenly and vehemently expanded, the texture of it was as ſuddenly altered, and the parts made ſo to ſhift places (and perhaps ſome of them to change poſtures) as during their new and vehement motion, and their varied ſituation, to diſturb the wonted continuity, and ſo the diaphaneity of the air; which (as we have already noted) upon its ceaſing to be a tranſparent body, without the interpoſition of coloured things, muſt eaſily degenerate into white.

SE-

SEVERAL things there were that made this conjecture ſeem the leſs improbable. As firſt, that the whiteneſs always appeared greater when the exſuction began to be made, whilſt there was ſtore of air in the receiver, than when the air was in great part drawn out. And next, that, having exhauſted the receiver, and applied to the hole in the ſtop-cock a large bubble of clear glaſs, in ſuch a manner, that we could at pleaſure let the air paſs out at the ſmall glaſs into the great one, and eaſily fill the ſmall one with air again, we obſerved with pleaſure, that, upon the opening the paſſage betwixt the two glaſſes, the air in the ſmaller having ſo much room in the greater to receive it, the diſſilition of that air was ſo great, that the ſmall phial ſeemed to be full of milk; and this experiment we repeated ſeveral times. To which we may add, that, having provided a ſmall receiver, whoſe upper orifice was ſo narrow that I could ſtop it with my thumb, I obſerved, that when, upon the exſuction of the air, the capacity of the glaſs appeared white, if, by a ſudden removal of my thumb, I let in the outward air, that whiteneſs would immediately vaniſh. And whereas it may be objected, that in the inſtance formerly mentioned, water turning from perſpicuous to white, there intervenes the air, which is a body of a heterogeneous nature, and muſt turn it into bubbles to make it loſe its tranſparency; we may borrow an anſwer from an experiment we deliver in another treatiſe, where we teach, how to make two very volatile liquors, which being gently put together, are clear as rock-water, and yet will almoſt in a moment, without the ſub-ingreſſion of air to turn them into bubbles, ſo alter the diſpoſition of their inſenſible parts, as to become a white and conſiſtent body. And this happens not as in the precipitation of benjamin, and ſome other reſinous bodies, which being diſſolved in ſpirit of wine, may, by the effuſion of fair water, be turned into a ſeemingly milky ſubſtance. For this whiteneſs belongs not to the whole liquor, but to the corpuſcles of the diſſolved gum, which after a while ſubſiding, leave the liquor tranſparent, themſelves only remaining white; whereas in our caſe, it is from the varied texture of the whole formerly tranſparent fluid body, and not from this or that part, that this whiteneſs reſults: for the body is white throughout, and will long continue ſo; and yet may, in proceſs of time, without any addition, be totally reduced into a tranſparent body as before.

BUT beſides the conjecture inſiſted on all this while, we grounded another upon the following obſervation; which was, that having conveyed ſome ſmoke into our receiver placed againſt a window, we obſerved, that upon the exſuction of the air, the corpuſcles that were ſwimming in it, did manifeſtly enough make the receiver ſeem more opacous at the very moment of the ruſhing out of the air: for conſidering that the whiteneſs, whoſe cauſe we inquire of, did but ſometimes appear, it ſeemed not impoſſible but that at ſuch times the air in the receiver might abound with particles, capable of reflecting the light in the manner requiſite to exhibite a white colour, by their being put into a certain unuſual motion: as may be in ſome meaſure illuſtrated by this, that the new motion of the freſhly mentioned fumes made the inſide of the receiver appear ſomewhat darker than before; and partly by the nature of our formerly mentioned ſmoking liquor, whoſe parts, though they ſeemed tranſparent whilſt they compoſed a liquor, yet when the ſame corpuſcles, upon the unſtopping of the glaſs, were put into a new motion, and diſpoſed after a new manner, they did opacate that part of the air they moved in, and exhibited a greater whiteneſs than that which ſometimes appears in our pneumatical veſſel. Nor ſhould we content our ſelves with this ſingle inſtance, to manifeſt, that little bodies, which being ranged after one manner are diaphanous and colourleſs, may, by being barely agitated, diſperſed, and conſequently otherways ranged, exhibit a colour, if we were not unwilling to rob our collection of experiments concerning colours.

BUT, my Lord, I foreſee you may make ſome objections againſt our propoſed gueſs, which perhaps I ſhall ſcarce be able to anſwer; eſpecially, if you inſiſt upon having me render a reaſon why our phænomenon appears not conſtantly.

I MIGHT indeed anſwer, that probably it would do ſo, if inſtead of our great receiver we uſe ſuch a ſmall phial as we have lately mentioned, wherein the diſſilition of the air being much greater, is like to be the more conſpicuous: ſince I remember not that we ever made our trial with ſuch ſmall veſſels, without finding the expected whiteneſs to appear. But it would remain to be explicated, why in our great receiver the phænomenon ſhould ſometimes be ſeen, and oftentimes not appear. And though that conjecture which we laſt made ſhould not be rejected, yet if we were farther preſſed to aſſign a reaſon why the air ſhould abound with ſuch particles, as we there ſuppoſe, more at one time than another, we are not yet provided of any better anſwer than this general one, that the air about us (and much more that within the receiver) may be much altered by ſuch cauſes as few are aware of: for, not to repeat thoſe probable arguments of this aſſertion which we have occaſionally mentioned here and there in the former part of this epiſtle, we will here ſet down two or three inſtances to verify the ſame propoſition. Firſt, I find that the learned *Joſephus Acoſta*, among other judicious obſervations he made in *America*, hath this concerning the effects of ſome winds: *There are*, ſaith he, *winds which naturally trouble the water of the ſea, and make it green, and black; others, clear as cryſtal.* Next, we have obſerved, that though we conveyed into the receiver our ſcales, and the pendula formerly mentioned, clean and bright; yet after the receiver had been emptied, and the air let in again, the gloſs or luſtre both of the one, and of the other, appeared tarniſhed by a beginning ruſt. And in the laſt place, we will ſubjoin an obſervation we made ſome years ago, which hath been heard

Joſeph Acoſta's *Nat. and Mor. Hiſt. of the Indies*, lib. 3. cap. 9.

heard of by divers ingenious men, and ſeen by ſome of them: We had, with pure ſpirit of wine, drawn a tincture out of a certain concrete, which uſeth to be reckoned among mineral bodies; and this tincture being very pure and tranſparent, we did, becauſe we put a great value upon it, put into a cryſtal phial, which we carefully ſtopped, and locked up in a preſs among ſome other things that we ſpecially prized. This liquor being a chymical rarity, and beſides very defecate, and of a pleaſing golden colour; we had often occaſion to look upon it, and ſo to take notice, that one time it ſeemed to be very much troubled, and not clear as it was wont to be: whereupon we imagined, that though it would be ſomething ſtrange, yet it was not impoſſible that ſome precipitation of the mineral corpuſcles was then happening, and that thence the liquor was opacated. But, finding after ſome days, that though the expected precipitation had not been made, yet the liquor, retaining its former vivid colour, was grown clear again as before, we ſomewhat wondered at it; and locking it up again in the ſame preſs, we reſolved to obſerve, both whether the like changes would again appear in our tincture, and whether in caſe they ſhould appear, they would be aſcribable to the alterations of the weather. But though, during the greateſt part of a winter and a ſpring, we took pleaſure to obſerve, how the liquor would often grow turbid, and after a while clear again; yet we could not find that theſe mutations depended upon any that were manifeſt in the air, which would be often dark and clouded, when the tincture was clear and tranſparent; as, on the other ſide, in clear weather the liquor would appear ſometimes troubled, and more opacous. So that being unable to give an account of theſe odd changes in our tincture (which we ſuppoſe we have not yet loſt, though we know not whether it hath loſt its fickle nature) either by thoſe of the air, or any thing elſe that occurred to our thoughts; we could not but ſuſpect, that there may be in divers bodies, as it were ſpontaneous mutations, that is, ſuch changes as depend not upon manifeſt cauſes. But, my Lord, what hath been all this while ſaid concerning our phænomenon, is offered to you, not as containing a ſatisfactory account of it, but to aſſiſt you to give your ſelf one.

EXPERIMENT XXXVIII.

WE took a glaſs veſſel, open at the top, and into it we put a mixture of ſnow and common ſalt, (ſuch a mixture as we have in another treatiſe largely diſcourſed of;) and into the midſt of this mixture we ſet a glaſs, of a cylindrical form, cloſely ſtopped at the lower end with plaiſter, and open at the upper, at which we filled it with common water. Theſe things being let down into the receiver, and the pump being ſet on work, the ſnow began to melt ſomewhat faſter than we expected; whether upon the account of the exſuction of the air, or becauſe there was but little of the ſnow, or whether for any other reaſon, it appeared doubtful. But however, by that time the receiver had been conſiderably exhauſted, which was done in leſs than $\frac{1}{4}$ of an hour, we perceived the water near the bottom of the glaſs cylinder to freeze, and the ice, by a little longer ſtay, ſeemed to increaſe, and to riſe ſomewhat higher than the ſurface of the ſurrounding liquor, whereinto almoſt all the ſnow and ſalt were reſolved. The glaſs being taken out, it appeared that the ice was as thick as the inſide of the glaſs it filled, though into that I could put my thumb. The upper ſurface of the ice was very concave, which, whether it were due to any unheeded accident, or to the exſuction of the air, we leave to be determined by farther trial. And laſtly, the ice held againſt the light, appeared not deſtitute of bubbles, though ſome by-ſtanders thought they were fewer than would have been found if the water had been frozen in the open air. The like experiment we tried alſo another time in one of our ſmall receivers, with not unlike ſucceſs.

AND on this occaſion, my Lord, give me leave to propoſe a problem, which ſhall be this: Whence proceeds that ſtrange force that we may ſometimes obſerve in frozen water, to break the bodies that impriſon it, though hard and ſolid? That there is ſuch a force in water expoſed to congelation, may be gathered not only from what may be often obſerved in winter, of the burſting of glaſſes too cloſe ſtopped, filled with water or aqueous liquors, but by inſtances as much more conſiderable as leſs obvious. For I remember, that an ingenious ſtone-cutter not long ſince complained to me, that ſometimes, through the negligence of ſervants, the rain being ſuffered to ſoak into marble ſtones, the ſupervening violent froſts would burſt the ſtones, to the poſſeſſor's no ſmall damage. And I remember another tradeſman, in whoſe houſe I had lodgings, was laſt winter complaining, that even implements made of bell-metal, being careleſly expoſed to the wet, have been broken and ſpoiled by the water; which, having gotten into the little cavities and crannies of the metal, was there afterwards frozen and expanded into ice. And to theſe relations, we can add one of the formerly mentioned *Cabæus*'s, whereby they not only may be confirmed, but are ſurpaſſed: for he tells us, that he ſaw a huge veſſel of exceeding hard marble ſplit aſunder by congealed water, whoſe rarefaction, ſaith our author, proved ſo vehement, that the hardneſs of the ſtone yielded to it; and ſo a veſſel was broken, which would not have been ſo by 100 yoke of oxen drawing it ſeveral ways. I know, my Lord, that to ſolve this problem, it will be ſaid, that congelation doth not (as is commonly, but erroneouſly preſumed) reduce water into leſs room than it poſſeſſed before, but rather makes it take up more. And I have elſewhere proved by particular experiments, that whether or no ice may be truly ſaid to be water rarefied (for that ſeems queſtionable) it may be ſaid to take up more room than the water did before glaciation. But though we grant that freezing makes water ſwell, yet, how cold

In lib 4. Meteor. Ariſt.

(which in weather-glaſſes manifeſtly condenſeth the air) ſhould expand either the water, or the intercepted air ſo forcibly, as to perform ſuch things as we have newly related, will yet remain a problem.

EXPERIMENT XXXIX.

WE took an oval glaſs, clear and (leſt it ſhould break) pretty ſtrong, with a ſhort neck at the obtuſer end; through this neck, we thruſt almoſt to the bottom, a pipe of glaſs, which was cloſely cemented to the newly mentioned neck; the upper part of which pipe was drawn in ſome places more ſlender than a crow's quill, that the changes of the air in that glaſs egg might be the more conſpicuous. Then there was conveyed into the glaſs five or ſix ſpoon-fulls of water, part of which, by blowing air into the egg, was raiſed into the abovementioned ſlender part of the pipe, ſo that the water was interpoſed between the external air, and that included in the egg. This weather glaſs (delineated in the fourteenth figure) was ſo placed, and cloſed up in the cavity of one of our ſmall receivers, that only the ſlender part of the pipe, to the height of four or five inches, paſſing thorough a hole in the cover, remained expoſed to the open air.

THE pump being ſet a work, upon the exſuction of the air, the water in the pipe deſcended about a quarter of an inch, and this upon two or three reiterated trials; which ſeemed ſufficiently to argue, that there was no heat produced in the receiver upon the exſuction of the air: for even a little heat would probably have been diſcovered by that weather-glaſs, ſince upon the bare application of my hand to the outſide of the receiver, the warmth having after ſome time been communicated or propagated through both the glaſſes, and the interval betwixt them, to the impriſoned air, did ſo rarefy that, as to enable it, by preſſing upon the ſubjacent water, to impel that in the pipe very many times as far as it had fallen downwards upon the exſuction of the air.

YET ſhall not we conclude, that in the cavity of the receiver the cold was greater after the exſuction of the air than before.

FOR if it be demanded what then could cauſe the forementioned ſubſiding of the water? it may be anſwered, that probably it was the reaching of the glaſs egg, which, upon the exſuction of the ambient air, was unable to reſiſt altogether as much as formerly the preſſure of the included air, and of the atmoſphere, which, by the intervention of the water, preſſed upon its concave ſurface. Which ſeemed probable, as well by what was above delivered, in the experiment about the breaking of the glaſs by the force of the atmoſphere, as by this notable circumſtance (which we divers times obſerved) that when by drawing the air out of the receiver, the water in the pipe was ſubſided, upon the readmiſſion of the external air, to preſs againſt the convex ſurface of the egg, the water was preſently re-impelled to its former height: which would perhaps appear leſs ſtrange to your Lordſhip, if you had yet ſeen, what we have heretofore taught in another treatiſe, concerning the ſpring that may be diſcovered in glaſs, as rigid and inflexible a body as it is generally eſteemed. And in the mean while it may ſerve the turn, to cauſe a glaſs egg to be blown exceeding thin; and then, having broken it, try how far you can by degrees bend ſome narrow parts of it; and how readily, upon the removal of what kept it bent, it will reſtore itſelf to its former ſtate or poſture. But to return to our experiment: From thence it ſeems probable, either that there ſucceeds no body in the room of the air drawn out of our receiver; or that it is not every matter that is ſubtile enough readily to paſs through the pores of glaſs, that is always agitated enough to produce heat wherever it is plentifully found. So that if no vacuum be to be admitted, this experiment ſeems to invite us to allow a great diſparity, either as to bulk, or as to agitation, or as to both, betwixt ſome parts of the etherial ſubſtance, and thoſe that are wont here below to produce heat and fire.

WE tried alſo what operation the drawing out of the air would have upon camphire, that being a body, which, though not a liquor, conſiſts of ſuch volatile or fugitive parts, that without any greater agitation than that of the open air itſelf, they will copiouſly fly away. But we found not that even this looſe body was ſenſibly altered by the exſuction of the ambient air.

EXPERIMENT XL.

IT may ſeem well worth trying, whether or no in our exhauſted glaſs the want of an ambient body, of the wonted thickneſs of air, would diſable even light and little animals, as bees, and other winged inſects, to fly. But though we eaſily foreſaw how difficult it would be to make ſuch an experiment, yet not to omit our endeavours, we procured a large fleſh-fly, which we conveyed into a ſmall receiver. We alſo another time ſhut into a great receiver a humming bee, that appeared ſtrong and lively, though we had rather have made the trial with a butterfly, if the cold ſeaſon would have permitted us to find any. * The fly, after ſome exſuctions of the air, dropped down from the ſide of the glaſs whereon ſhe was walking. But, that the experiment with the bee might be the more inſtructive, we conveyed in with her a bundle of flowers, which remained ſuſpended by a ſtring near the upper part of the receiver; and having provoked the bee, we excited her to fly up and down the capacity of the veſſel, till at length, as we deſired, ſhe lighted upon the flowers: whereupon we preſently began to draw out the air, and obſerved, that though for ſome time the bee ſeemed to take no notice of it, yet within a while after ſhe did not fly, but fall down from the flowers, without appearing

* Since the writing of this XLth experiment, we procured a white butterfly, and incloſed it in one of our ſmaller receivers, where, though at firſt he fluttered up and down, yet preſently, upon the exſuction of the air, he fell down as in a ſwoon, retaining no other motion than ſome little trembling of the wings.

pearing to make any uſe of her wings to help her ſelf. But whether this fall of the bee, and the other inſect, proceeded from the medium's being too thin for them to fly in, or barely from the weakneſs, and as it were ſwooning of the animals themſelves, you will eaſily gather from the following experiment.

EXPERIMENT XLI.

TO ſatisfy our ſelves in ſome meaſure about the account upon which reſpiration is ſo neceſſary to the animals, that nature hath furniſhed with lungs, we took (being then unable to procure any other lively bird, ſmall enough to be put into the receiver) a lark, one of whoſe wings had been broken by a ſhot, of a man that we had ſent to provide us ſome birds for our experiment; but notwithſtanding this hurt, the lark was very lively, and did, being put into the receiver, divers times ſpring up in it to a good height. The veſſel being haſtily, but carefully cloſed, the pump was diligently plied, and the bird for a while appeared lively enough; but upon a greater exſuction of the air, ſhe began manifeſtly to droop and appear ſick, and very ſoon after was taken with as violent and irregular convulſions, as are wont to be obſerved in poultry, when their heads are wrung off: for the bird threw her ſelf over and over two or three times, and died with her breaſt upward, her head downwards, and her neck awry. And though upon the appearing of theſe convulſions, we turned the ſtop-cock, and let in the air upon her, yet it came too late; whereupon caſting our eyes upon one of thoſe accurate dials that go with a pendulum, and were of late ingeniouſly invented by the noble and learned *Hugenius*, we found that the whole tragedy had been concluded within ten minutes of an hour, part of which time had been employed in cementing the cover to the receiver. Soon after we got a hen-ſparrow, which being caught with bird-lime was not at all hurt; when we put her into the receiver, almoſt to the top of which ſhe would briſkly raiſe her ſelf, the experiment being tried with this bird, as it was with the former, ſhe ſeemed to be dead within ſeven minutes, one of which were employed in cementing on the cover: but upon the ſpeedy turning of the key, the freſh air flowing in, began ſlowly to revive her, ſo that after ſome pantings ſhe opened her eyes, and regained her feet, and in about $\frac{1}{4}$ of an hour after, threatned to make an eſcape at the top of the glaſs, which had been unſtopped to let in the freſh air upon her: but the receiver being cloſed the ſecond time, ſhe was killed with violent convulſions, within five minutes from the beginning of the pumping.

A WHILE after we put in a mouſe, newly taken, in ſuch a trap as had rather affrighted than hurt him; whilſt he was leaping up very high in the receiver, we faſtened the cover to it, expecting that an animal uſed to live in narrow holes with very little freſh air, would endure the want of it better than the lately mentioned birds: but though, for a while after the pump was ſet a work, he continued leaping up as before; yet, it was not long ere he began to appear ſick and giddy, and to ſtagger: after which he fell down as dead, but without ſuch violent convulſions as the bird died with. Whereupon, haſtily turning the key, we let in ſome freſh air upon him, by which he recovered, after a while, his ſenſes and his feet; but ſeemed to continue weak and ſick: but at length, growing able to ſkip as formerly, the pump was plied again for eight minutes, about the middle of which ſpace, if not before, a little air by a miſchance got in at the ſtop-cock; and about two minutes after that, the mouſe divers times leaped up lively enough, though after about two minutes more he fell down quite dead, yet with convulſions far milder than thoſe wherewith the two birds expired. This alacrity ſo little before his death, and his not dying ſooner than at the end of the eighth minute, ſeemed aſcribable to the air (how little ſoever) that ſlipt into the receiver. For the firſt time, thoſe convulſions (that, if they had not been ſuddenly remedied, had immediately diſpatched him) ſeized on him in ſix minutes after the pump began to be ſet a work. Theſe experiments ſeemed the more ſtrange, in regard that during a great part of thoſe few minutes the engine could but conſiderably rarefy the air (and that too, but by degrees) and at the end of them there remained in the receiver no inconſiderable quantity; as may appear by what we have formerly ſaid of our not being able to draw down water in a tube, within much leſs than a foot of the bottom: with which we likewiſe conſidered, that by the exſuction of the air and interſperſed vapours, there was left in the receiver a ſpace ſome hundreds of times exceeding the bigneſs of the animal, to receive the fuliginous ſteams, from which exſpiration diſcharges the lungs; and, which in the other caſes hitherto known, may be ſuſpected, for want of room, to ſtifle thoſe animals that are cloſely penned up in too narrow receptacles.

I FORGOT to mention, that having cauſed theſe three creatures to be opened, I could, in ſuch ſmall bodies, diſcover little of what we ſought for, and what me might poſſibly have found in larger animals; for though the lungs of the birds appeared very red, and as it were inflamed, yet that colour being uſual enough in the lungs of ſuch winged creatures, deſerves not ſo much our notice, as it doth, that in almoſt all the deſtructive experiments made in our engine, the animals appeared to die with violent convulſive motions: from which, whether phyſicians can gather any thing towards the diſcovery of the nature of convulſive diſtempers, I leave to them to conſider.

HAVING proceeded thus far, though (as we have partly intimated already) there appeared not much cauſe to doubt, but that the death of the forementioned animals proceeded rather from the want of air, than that the air was overclogged by the ſteams of their bodies, exquiſitely penned up in the glaſs; yet I, that love not to believe any thing upon conjectures, when by a not over-difficult experiment I can try whether it be true or no, thought it the

ſafeſt

ſafeſt way to obviate objections, and remove ſcruples, by ſhutting up another mouſe as cloſe as I could in the receiver; wherein it lived about three quarters of an hour, and might probably have done ſo, much longer, had not a Virtuoſo of quality, who in the mean while chanced to make me a viſit, deſired to ſee whether or no the mouſe could be killed by the exſuction of the ambient air: whereupon we thought fit to open, for a little while, an intercourſe betwixt the air in the receiver, and that without it, that the mouſe might thereby (if it were needful for him) be refreſhed; and yet we did this without uncementing the cover at the top, that it might not be objected, that perhaps the veſſel was more cloſely ſtopped for the exſuction of the air than before.

THE experiment had this event, that after the mouſe had lived ten minutes, (which we aſcribed to this, that the pump, for want of having been lately oiled, could move but ſlowly, and could not by him that managed it be made to work as nimbly as it was wont) at the end of that time he died with convulſive fits, wherein he made two or three bounds into the air, before he fell down dead.

NOR was I content with this, but for your Lordſhip's farther ſatisfaction, and my own, I cauſed a mouſe, that was very hungry, to be ſhut in all night, with a bed of paper for him to reſt upon; and to be ſure that the receiver was well cloſed, I cauſed ſome air to be drawn out of it, whereby, perceiving that there was no ſenſible leak, I preſently readmitted the air at the ſtop-cock, leſt the want of it ſhould harm the little animal; and then I cauſed the engine to be kept all night by the fire-ſide, to keep him from being deſtroyed by the immoderate cold of the froſty night. And this care ſucceeded ſo well, that the next morning I found that the mouſe not only was alive, but had devoured a good part of the cheeſe that had been put in with him. And having thus kept him alive full twelve hours, or better, we did, by ſucking out part of the air, bring him to droop, and to appear ſwelled; and by letting in the air again, we ſoon reduced him to his former livelineſs.

A Digreſſion containing ſome Doubts touching RESPIRATION.

I FEAR your Lordſhip will now expect, that to theſe experiments I ſhould add my reflections on them, and attempt, by their aſſiſtance, to reſolve the difficulties that occur about reſpiration; ſince at the beginning I acknowledged a farther inquiry into the nature of that, to have been my deſign in the related trials. But I have yet, becauſe of the inconvenient ſeaſon of the year, made ſo few experiments, and have been ſo little ſatisfied by thoſe I have been able to make, that they have hitherto made reſpiration appear to me rather a more, than a leſs myſterious thing, than it did before. But yet, ſince they have furniſhed me with ſome ſuch new conſiderations, concerning the uſe of the air, as confirms me in my diffidence of the truth of what is commonly believed touching that matter; that I may not appear ſullen or lazy, I am content not to decline employing a few hours in ſetting down my doubts, in preſenting your Lordſhip ſome hints, and in conſidering whether the trials made in our engine will at leaſt aſſiſt us to diſcover wherein the deficiency lies that needs to be ſupplied.

AND this, my Lord, being all my preſent deſign, I ſuppoſe you will not expect that (as if you knew not, or had forgotten what Anatomiſts are wont to teach) I ſhould entertain you with a needleſs diſcourſe of the organs of reſpiration, and the variety of their ſtructure in ſeveral animals; though if it were neceſſary, and had not been performed by others, I ſhould think, with *Galen*, that by treating of the fabricks of living bodies, I might compoſe hymns to the wiſe author of nature, who, in the excellent contrivance of the lungs, and other parts of (thoſe admirable engines) animals, manifeſts himſelf to be indeed what the eloquent prophet moſt juſtly ſpeaks him, *wonderful in counſel, and excellent in working*.

NOR ſhall we any farther meddle with thoſe controverſies ſo much agitated among the moderns, namely, whether the motion of the lungs in reſpiration be their own, or but conſequent to the motion of the thorax, diaphragm, and (as ſome learned men would have it) the abdomen; and, whence it is that the air ſwells the lungs in inſpiration, any farther than they may receive light from our engine: but that it may appear what kind of ſervice it is that may be expected from it on this occaſion, we muſt premiſe a few words to ſhew wherein the ſtrength of the objection we are to anſwer, lies. In favour then of thoſe that would have the lungs rather paſſive than active in the buſineſs of reſpiration, it may againſt the common opinion be alledged, that as the lungs being deſtitute of muſcles and of fibres, are unfit to dilate themſelves; ſo it appears, that without the motion of the thorax they would not be filled with air. Since, as our learned friend Dr. *Highmore* hath well (and congruouſly to what our ſelves have purpoſely tried) obſerved, if a live dog have a great wound made in his cheſt, the lobes of the lungs on that ſide of the mediaſtinum will ſubſide and lie ſtill; the thorax and the lobes on the other ſide of the mediaſtinum continuing their former motion. And if ſuddenly at once the muſcles of the cheſt be on both ſides diſſected, upon the ingreſs of the air, the whole lungs, though untouched, will remain moveleſs, at leaſt, as to any expanſion or contraction of their ſubſtance.

TO which we may add the obſervation of the diligent *Bartholinus*, who affirms the like of the diaphragm alſo; namely, that it being wounded, the lungs will fall together, and the reſpiration ceaſe, which my experiments oppoſe not, provided the wound be any thing great. And indeed the diaphragm ſeems the principal inſtrument of ordinary and gentle reſpiration, although to reſtrained reſpiration (if I may ſo call it) the intercoſtal muſcles, and perhaps ſome others may be allowed eminently to concur. But the chief of the controverſies formerly pointed at, is not yet decided; namely, what

it is that conveys the air into the lungs. For when, to counterbalance all that hath been alledged, thoſe that plead for the lungs demand what it is that ſhould bring the air into the lungs, if themſelves do not attract it, their antagoniſts diſagree about the reply. For when to this queſtion ſome of the beſt modern philoſophers anſwer, that by the dilatation of the cheſt the contiguous air is thruſt away, and that preſſing upon the next air to it, and ſo onwards, the propulſion is continued till the air be driven into the lungs, and ſo dilate them; when this (I ſay) is anſwered, it is objected even by *Bartholine* himſelf, as a convincing reply, that, according to this doctrine, a man could not fetch his breath from a great veſſel full of air, with a ſlender neck; becauſe, that when his mouth covers the orifice of the neck, the dilatation of his thorax could not propel the air in the veſſel into his lungs, by reaſon of its being ſeparated by the incloſing veſſel from the ambient air; and yet, ſay they, experience witneſſeth, that out of ſuch a veſſel a man may ſuck air. But of this difficulty our engine furniſheth us with an eaſy ſolution, ſince many of the former experiments have manifeſted, that in the caſe propoſed, there needs not be made any (though it is true that in ordinary reſpiration there is wont to be made ſome) propulſion of the air by the ſwelling thorax or abdomen into the lungs; ſince upon the bare dilatation of the thorax, the ſpring of that internal air, or halitious ſubſtance that is wont to poſſeſs as much of the cavity of the cheſt as the lungs fill not up, being much weakened, the external and contiguous air muſt neceſſarily preſs in at the open wind-pipe into the lungs, as finding there leſs reſiſtance than any where elſe about it.

AND hence (by the way) we may derive a new aſſiſtance to judge of that famous controverſy diſputed among Naturaliſts and Phyſicians, ever ſince *Galen*'s time, ſome maintaining that the cheſt, with the contained lungs, may be reſembled to a pair of bellows, which comes therefore to be filled becauſe it was dilated; and others pleading to have the compariſon made to a bladder, which is therefore dilated becauſe it is filled. For as to the thorax, it ſeems evident from what hath been lately ſaid, that it, like a pair of bellows, happens to be partly filled with air, but becauſe it was dilated: but as for the lungs themſelves, who want fibres to diſtend them, they may fitly enough be compared to a bladder; ſince they are dilated by being filled, namely, by that air which ruſheth into them upon the dilatation of the cheſt, in whoſe increaſed cavity it finds (as we freſhly noted) leſs reſiſtance to its ſpring than elſewhere. And this brings into my mind that ſtrange obſervation of *Nicolaus Fontanus*, a phyſician at *Amſterdam*, who teſtifieth, that in a boy of the ſame town, four years old, there was found, inſtead of lungs, a certain membranous bladder; which being filled with wind, and furniſhed with little veins, had its origination from the wind-pipe it ſelf: which being ſuppoſed true, how well it will agree with moſt of the opinions touching reſpiration, I leave to be conſidered.

AND thus may the grand objection of *Bartholine*, and others, be anſwered: but I leave to Anatomiſts to conſider what is to be ſaid to ſome obſervations that ſeem to contradict thoſe anatomical experiments already mentioned: ſuch was particularly that which I remember I have read in *Sennertus* (from the obſervation of his father-in-law *Schato*) of a melancholy ſtudent, who having ſtabbed himſelf, and pierced the diaphragm in the thinner or tendonous part (called by many the nervous circle) lived ſeven months after he had wounded himſelf, though after his death (preceded by violent vomitings) the wound (perchance dilated by thoſe ſtrainings) appeared ſo great, that the whole ſtomach was found to have got in by it into the left ſide of the thorax. And ſuch alſo was the accident that happened to a nobleman, whom I remember I have ſeen, and who is yet alive, in whoſe cheſt there hath, for theſe many years, remained a hole ſo great, that the motion of his heart may be perceived by it. Theſe (I ſay) and ſome other obſervations, I ſhall now forbear to inſiſt on, becauſe I hold it not unfit, before we come to conſider the uſe of reſpiration, that we acquaint your Lordſhip with an ingenious conjecture, that was made at the cauſe of the haſty death of the animals our engine killed; namely, that it was not the want of air that deſtroyed them, but the preſſure of the innate air in the cavity of the cheſt: as if the ſpring of the air being no longer counterbalanced by the ambient air, was thereby become ſo ſtrong, that it kept the thorax forciby diſtended, and hindered its wonted contraction; and ſo compreſſed the lungs and their veſſels, as to obſtruct the circulation of the blood. And this conjecture, as it is ſpecious enough, ſo I might have admitted it for true; but that I conſidered, that (not to mention that one, eſpecially of the animals killed in our engine, ſeemed manifeſtly for a pretty while, and not long before he died, to move his thorax, as if he exerciſed reſpiration) the diligent *Wallæus* relates, that he divers times obſerved, in the diſſection of live bodies, that the membrane that inveſts the lungs had pores in it as big as the larger ſort of peas; which agreeth with the obſervations of chirurgeons and phyſicians, *viz.* that matter collected in the thorax hath penetrated into the lungs, and been diſcharged by coughing. And I remember too, that moſt of the animals we killed in our engine were birds, of whoſe lungs *Harvey* ſomewhere informs us, that he obſerved them very manifeſtly to open at their extremities into the abdomen; and by ſuch perforations we may well ſuppoſe the paſſage free betwixt the external air, and that in the abdomen: but this conjecture may be farther conſidered. Beſides, to ſhow that the animals that died in our glaſſes, need not be ſuppoſed to have been killed by the want of air, we foreſee another argument, that we muſt deal ſo ingenuouſly with your Lordſhip, as not to conceal. You very well know, that beſides the generality of the ſchools, there are many new philoſophers, who, though they diſſent from the old Peripateticks in other things, do,

as they, deny the poſſibility of a vacuum; and hold, that thoſe ſpaces which are devoid of air, and other groſſer bodies, are all of them exactly repleniſhed with a certain etherial matter, ſo thin and ſubtile, that it can freely permeate the pores of the cõpactedſt and cloſeſt bodies, and even of glaſs it ſelf. Now ſome of thoſe Naturaliſts that are of this perſuaſion may object, that the animals that died in our receiver, did ſo, not ſo much for lack of air, as by reaſon that the air that was pumped out was neceſſarily ſucceeded by an etherial ſubſtance; which conſiſting of parts vehemently agitated, and ſo very ſmall, as without reſiſtance to paſs in and out through the very pores of glaſs; it may well be ſuppoſed, that a conſiderable quantity of this reſtleſs and ſubtile matter, meeting together in the receiver, with the exceſſive heat of it, may be quickly able to deſtroy a little animal, or at leaſt make the air too intemperately hot to be fit for reſpiration.

BUT though this be a difficulty not ſo eaſily to be reſolved without the aſſiſtance of our engine, yet I ſuppoſe we have already anſwered the objection by our 38th and 39th experiments; which, though we made partly for other purpoſes, yet we premiſed them only to clear up the difficulty propoſed.

ANOTHER ſuſpicion we ſhould have entertained concerning the death of our animals; namely, that upon the ſudden removal of the wonted preſſure of the ambient air, the warm blood of thoſe animals was brought to an efferveſcence or ebullition; or at leaſt ſo vehemently expanded, as to diſturb the circulation of the blood, and ſo diſorder the whole œconomy of the body: This, I ſay, I ſhould have had ſome ſuſpicion of, but that animals of a hot conſtitution are not the ſole ones that cannot in our exhauſted engine exerciſe the function of life. But I muſt not now dwell upon matters of this nature, becauſe I think it high time to proceed to the conſideration of the principal ſubject of our engine, namely, the uſe of reſpiration; or rather, the uſe of the air in reſpiration. For whereas of the divers uſes of it mentioned by Anatomiſts, the moſt, ſuch as the production and modulation of the voice by the eliſion of the air, the larynx, *&c.* the expulſion of excrements by coughing, the conveying in of odours by inſpiration, and ſome others, rather convenient for the well-being of an animal, than abſolutely neceſſary to his life; whereas (I ſay) the other uſes are ſuch as we have ſaid, the great *Hippocrates* himſelf gives this notable teſtimony to the uſe of the air, as to animals endowed with lungs: *Mortalibus* (ſaith he) *hic* (ſpiritus) *tum vitæ, tum morborum ægrotis cauſa eſt. Tantaque corporibus omnibus ſpiritûs ineſt neceſſitas, ut ſiquidem aliis omnibus & cibis & potionibus, quis abſtineat, duos tamen aut tres, vel plures dies poſſit vitam ducere: At ſi quis ſpiritus in corpus vias intercipiat, vel exiguâ diei parte, homini pereundum ſit; adeo neceſſarius eſt uſus ſpiritûs in corpore. Ad hæc quoque, quum omnibus aliis actionibus homines quieſcant, quod mutationibus innumeris vita ſit expoſita, ab hâc tamen ſolâ actione nunquam deſiſtant animantia, quin aut ſpiritum adducant, aut reddant.*

BUT touching the account upon which the inſpiration and exſpiration of air (both which are comprehended in ἀναπνοὴ, reſpiration) is ſo neceſſary to life, both Naturaliſts and Phyſicians do ſo diſagree, that it will be very difficult either to reconcile their opinions, or determine their controverſies.

FOR firſt, many there are, who think the chief, if not ſole uſe of reſpiration, to be the cooling and tempering of that heat in the heart and blood, which otherwiſe would be immoderate; and this opinion not only ſeems to be moſt received amongſt ſcholaſtick writers, but divers of the new philoſophers, Carteſians and others, admitted with ſome variation; teaching, that the air is neceſſary, by its coldneſs, to condenſe the blood that paſſeth out of the right ventricle of the heart into the lungs, that thereby it may contain ſuch a conſiſtence as is requiſite to make it fit fewel for the vital fire or flame, in the left ventricle of the heart. And this opinion ſeems favoured by this, that fiſhes, and other cold creatures, whoſe hearts have but one cavity, are alſo unprovided of lungs, and by ſome other conſiderations. But though it need not be denied, that the inſpired air may ſometimes be of uſe by refrigerating the heart, yet (againſt the opinion that makes this refrigeration the moſt genuine and conſtant uſe of the air) it may be objected, that divers cold creatures (ſome of which, as particularly frogs, live in the water) have yet need of reſpiration; which ſeems not likely to be needed for refrigeration by them that are deſtitute of any ſenſible heat, and beſides, live in the cold water: that even decrepid old men, whoſe natural heat is made very languid, and almoſt extinguiſhed by reaſon of age, have yet a neceſſity of frequent reſpiration: that a temperate air is fitteſt for the generality of breathing creatures; and as an air too hot, ſo alſo an air too cold may be inconvenient for them (eſpecially if they be troubled with an immoderate degree of the ſame quality which is predominant in the air:) that in ſome diſeaſes the natural heat is ſo weakened, that in caſe the uſe of reſpiration were too cool, it would be more hurtful than beneficial to breathe; and the ſuſpending of the reſpiration may ſupply the place of thoſe very hot medicines that are wont to be employed in ſuch diſtempers: that nature might much better have given the heart but a moderate heat, than ſuch an exceſſive one, as needs to be perpetually cooled, to keep it from growing deſtructive; which the gentle, and not the burning heat of an animal's heart, ſeems not intenſe enough ſo indiſpenſably to require. Theſe, and other objections might be oppoſed, and preſſed againſt the recited opinion; but we ſhall not inſiſt on them, but only add to them, that it appears not by our foregoing experiments (I mean the the 38th and 39th) that in our exhauſted receiver, where yet animals die ſo ſuddenly for want of reſpiration, the ambient body is ſenſibly hotter than the common air.

OTHER learned men there are, who will have the very ſubſtance of the air to get in by

the

the veſſels of the lungs, to the left ventricle of the heart, not only to temper its heat, but to provide for the generation of ſpirits. And theſe alledge for themſelves the authority of the ancients, among whom *Hippocrates* ſeems manifeſtly to favour their opinion; and both *Ariſtotle* and *Galen* do ſometimes (for methinks they ſpeak doubtfully enough) appear inclinable to it. But for aught ever I could ſee in diſſections, it is very difficult to make out, how the air is conveyed into the left ventricle of the heart, eſpecially the ſyſtole and diaſtole of the heart and lungs being very far from being ſynchronical: beſides, that the ſpirits ſeeming to be but the moſt ſubtile and unctuous particles of the blood, appear to be of a very differing nature from that of the lean and incombuſtible corpuſcles of air. Other objections againſt this opinion have been propoſed, and preſſed by that excellent Anatomiſt, and my induſtrious friend Dr. *Highmore*, to whom I ſhall therefore refer you.

ANOTHER opinion there is touching reſpiration, which makes the genuine uſe of it to be ventilation not of the heart, but of the blood, in its paſſage through the lungs; in which paſſage it is diſburthened of thoſe excrementitious ſteams proceeding, for the moſt part, from the ſuperfluous ſeroſities of the blood, (we may add) and of the chyle too, which (by thoſe new conduits of late very happily detected by the famous *Pecquet*) hath been newly mixed with it in the heart. And this opinion is that of the induſtrious *Mœbius*, and is ſaid to have been that of that excellent philoſopher *Gaſſendus*; and hath been, in part, an opinion almoſt vulgar. But this hypotheſis may be explicated two ways: for firſt, the neceſſity of the air in reſpiration may be ſuppoſed to proceed from hence; that as a flame cannot long burn in a narrow and cloſe place, becauſe the fuliginous ſteams it inceſſantly throws out, cannot be long received into the ambient body; which, after a while, growing too full of them to admit any more, ſtifles the flame: ſo that the vital fire in the heart requires an ambient body of a yielding nature, to receive into it the ſuperfluous ſeroſities, and other recrements of the blood, whoſe ſeaſonable expulſion is requiſite to depurate the maſs of blood and make it fit, both to circulate and to maintain the vital heat reſiding in the heart. The other way of explicating the above-mentioned hypotheſis is, by ſuppoſing, that the air doth not only, as a receptacle, admit into its pores the excrementitious vapours of the blood, when they are expelled through the wind-pipe, but doth alſo convey them out of the lungs, in regard that the inſpired air reaching to all the ends of the *aſpera arteria*, doth there aſſociate it ſelf with the exhalations of the circulating blood, and when it is exploded, carries them away with it ſelf: as we ſee that winds ſpeedily dry up the ſurfaces of wet bodies, not to ſay any thing of what we formerly obſerved touching our liquor, whoſe fumes were ſtrangely elevated upon the ingreſs of the air.

Now, of theſe two ways of explicating the uſe of reſpiration, our engine affords us this objection againſt the firſt; that upon the exſuction of the air, the animal dies a great deal ſooner than if it were left in the veſſel; though by that exſuction, the ambient ſpace is left much more free to receive the ſteams that are either breathed out of the lungs of the animal, or diſcharged by inſenſible tranſpiration through the pores of his ſkin.

BUT if the hypotheſis propoſed be taken in the other ſenſe, it ſeems congruous enough to that grand obſervation, which partly the phænomena of our engine, and partly the relations of travellers, have ſuggeſted to us; namely, that there is a certain conſiſtence of air requiſite to reſpiration: ſo that if it be too thick, and already over-charged with vapours, it will be unfit to unite with, and carry off thoſe of the blood, as water will diſſolve and aſſociate to it ſelf but a certain proportion of ſaline corpuſcles; and if it be too thin or rarefied, the number or ſize of the aërial particles is too ſmall to be able to carry off the halituous excrements of the blood, in ſuch plenty as is requiſite.

NOW that air too much thickened (and as it were clogged) with ſteams, is unfit for reſpiration, may appear by what is wont to happen in the lead-mines of *Devonſhire*, (and for aught I know, in thoſe too of other countries, though I have ſeen mines where no ſuch thing was complained of) for I have been informed by more than one credible perſon (and particularly by an ingenious man that hath often, for curioſity, digged in thoſe mines, and been employed about them) that there often riſeth damps, (as retaining the German word by which we call them) which doth ſo thicken the air, that, unleſs the work-men ſpeedily make ſigns to them that are above, they would (which alſo ſometimes happens) be preſently ſtifled for want of breath: and though their companions do make haſte to draw them up, yet frequently, by that time they come to the free air, they are, as it were, in a ſwoon, and are a good while before they come to themſelves again. And that this ſwooning ſeems not to proceed from any arſenical or poiſonous exhalation contained in the damp, as from its over-much condenſing the air, ſeems probable from hence; that the ſame damps oftentimes leiſurely extinguiſh the flames of their candles or lamps; and from hence alſo that it appears (by many relations of authentical authors) that in thoſe cellars where great ſtore of new wine is ſet to work, men have been ſuffocated by the too great plenty of the ſteams exhaling from the muſt, and too much thickning the air: as may be gathered from the cuſtom that is now uſed in ſome hot countries, where thoſe that have occaſion to go into ſuch cellars, carry with them a quantity of well-kindled coals, which they hold near their faces; whereby it comes to paſs, that the fire diſcuſſing the fumes, and rarefying the air, reduceth the ambient body to a conſiſtence fit for reſpiration.

WE will add (by way of confirmation) the following experiment: In ſuch a ſmall receiver, as thoſe wherein we killed divers birds, we carefully cloſed up one, who, though for a quarter of an hour he ſeemed not much prejudiced by the cloſeneſs of his priſon, afterwards

wards began firſt to pant very vehemently, and keep his bill very open, and then to appear very ſick; and laſt of all, after ſome long and violent ſtrainings, to caſt up ſome little matter out of his ſtomach; which he did ſeveral times, till growing ſo ſick that he ſtaggered and gaſped, as being juſt ready to die. We perceived, that within about three quarters of an hour from the time that he was put in, he had ſo thickened and tainted the air with the ſteams of his body, that it was become altogether unfit for the uſe of reſpiration: which he will not much wonder at, who hath taken notice in *Sanctorius* his *Statica Medicina*, how much that part of our aliments which goeth off by inſenſible tranſpiration, exceeds in weight all the viſible and groſſer excrements both ſolid and liquid.

THAT (on the other ſide) an air too much dilated is not ſerviceable for the ends of reſpiration, the haſty death of the animal we killed in our exhauſted receiver ſeems ſufficiently to manifeſt. And it may not irrationally be doubted, whether or no, if a man were raiſed to the very top of the atmoſphere, he would be able to live many minutes, and would not quickly die for want of ſuch air as we are wont to breathe here below. And that this conjecture may not appear extravagant, I ſhall, on this occaſion, ſubjoin a memorable relation that I have met with in the learned *Joſephus Acoſta*, who tells us, that when he himſelf paſſed the high mountains of *Peru*, (which they call *Pariacaca*) to which, he ſays, that the *Alps* themſelves ſeem'd to them but as ordinary houſes in regard of high towers, he and his companions were ſurprized with ſuch extreme pangs of ſtraining and vomiting, (not without caſting up blood too) and with ſo violent a diſtemper, that he concludes he ſhould undoubtedly have died, but that this laſted not above three or four hours, before they came into a more convenient and natural temperature of air: to which our learned author adds an inference, which being the principal thing I deſigned in mentioning, the narrative, I ſhall ſet down in his own words: *I therefore* (ſays he) *perſuade my ſelf, that the element of the air is there ſo ſubtile and delicate, as it is not proportionable with the breathing of man, which requires a more groſs and temperate air; and I believe it is the cauſe that doth ſo much alter the ſtomach, and trouble all the diſpoſition.* Thus far our author, whoſe words I mention, that we may gueſs, by what happens ſomewhat near the confines of the atmoſphere (though probably far from the ſurface of it) what would happen beyond the atmoſphere. That, which ſome of thoſe that treat of the height of mountains, relate out of *Ariſtotle*, namely, that thoſe that aſcend to the top of the mountain *Olympus*, could not keep themſelves alive, without carrying with them wet ſpunges, by whoſe aſſiſtance they could reſpire in that air, otherwiſe too thin for reſpiration; (that relation, I ſay, concerning this mountain) would much confirm what hath been newly recited out of *Acoſta*, if we had ſufficient reaſon to believe it. But I confeſs I am very diffident of the truth of it; partly, becauſe when I paſſed the *Alps*, I took notice of no notable change betwixt the conſiſtence of the air at the top and the bottom of the mountain; partly, becauſe in a punctual relation made by an Engliſh gentleman, of his aſcenſion to the top of the pike of *Tenariff* (which is by great odds higher than *Olympus*) I find no mention of any ſuch difficulty of breathing; and partly alſo, becauſe the ſame author tells us out of *Ariſtotle*, that upon the top of *Olympus* there is no motion of the air, inſomuch that letters traced upon the duſt, have been, after many years, found legible and not diſcompoſed; whereas that inquiſitive *Buſbequius* (who was ambaſſador from the German to the Turkiſh emperor) in one of his eloquent Epiſtles, tells us, upon his own knowledge, that Olympus *may be ſeen from* Conſtantinople, *blanched with perpetual ſnow*; which ſeems to argue, that the top of that, as well as of divers other tall hills, is not above that region of the air wherein meteors are formed. Though otherwiſe, in that memorable narrative which *David Frælichius* made, of his aſcent to the top of the prodigiouſly high Hungarian mountain *Carpathus*, he tells us, *That when having paſſed through very thick clouds, he came to the very top of the hill, he found the air ſo calm and ſubtile, that not a hair of his head moved; whereas, in the lower ſtages of the mountain, he felt a vehement wind.* But this might well be caſual, as was his, having a clear air where he was, though there were clouds, not only beneath him, but above him.

Epiſt. 3.

Frælichius apud Varen. Geogra. Gener. lib. 1. *cap.* 19.

BUT, though what hath been hitherto diſcourſed, incline us to look upon the ventilation and depuration of the blood, as one of the principal and conſtant uſes of reſpiration; yet methinks it may be ſuſpected that the air doth ſomething more than barely help to carry off what is thrown out of the blood, in its paſſage through the lungs, from the right ventricle of the heart to the left. For we ſee, in phlegmatick conſtitutions and diſeaſes, that the blood will circulate tolerably well, notwithſtanding its being exceſſively ſerous: and in aſthmatical perſons, we often ſee, that though the lungs be very much ſtuffed with tough phlegm, yet the patient may live ſome months, if not ſome years. So that it ſeems ſcarce probable, that either the want of throwing out the ſuperfluous ſerum of the blood for a few moments, or the detaining it, during ſo ſhort a while, in the lungs, ſhould be able to kill a perfectly ſound and lively animal: I ſay, for a few moments, becauſe, that having divers times tried the experiment of killing birds in a ſmall receiver, we commonly found, that within half a minute of an hour, or thereabout, the bird would be ſurpriſed by mortal convulſions, and within about a minute more would be ſtark dead, beyond the recovery of the air, though never ſo haſtily let in. Which ſort of experiments ſeem ſo ſtrange, that we were obliged to make it ſeveral times, which gained it the advantage of having perſons of differing qualities, profeſſions and ſexes, (as not only ladies and lords, but doctors and mathematicians) to witneſs it. And to ſatisfy your lordſhip, that it

was

was not the narrowneſs of the veſſel, but the ſudden exſuction of the air that diſpatched theſe creatures ſo ſoon; we will add, that we once incloſed one of theſe birds in one of theſe ſmall receivers, where, for a while, he was ſo little ſenſible of his impriſonment, that he eat very chearfully certain ſeeds that were conveyed in with him, and not only lived ten minutes, but had probably lived much longer, had not a great perſon, that was ſpectator of ſome of theſe experiments, reſcued him from the proſecution of the trial. Another bird being within about half a minute caſt into violent convulſions, and reduced into a ſprawling condition, upon the exſuction of the air, by the pity of ſome fair ladies, related to your Lordſhip, who made me haſtily let in ſome air at the ſtop-cock, the gaſping animal was preſently recovered, and in a condition to enjoy the benefit of the ladies compaſſion. And another time alſo, being reſolved not to be interrupted in our experiment, we did at night ſhut up a bird in one of our ſmall receivers, and obſerved that for a good while he ſo little felt the alteration of the air, that he fell aſleep with his head under his wing; and though he afterwards awaked ſick, yet he continued upon his legs between forty minutes and three quarters of an hour: after which, ſeeming ready to expire, we took him out, and ſoon found him able to make uſe of the liberty we gave him for a compenſation of his ſufferings.

IF to the foregoing inſtances of the ſudden deſtruction of animals, by the removal of the ambient air, we ſhould now annex ſome, that we think fitter to reſerve till anon; perhaps your Lordſhip would ſuſpect, with me, that there is ſome uſe of the air which we do not yet ſo well underſtand, that makes it ſo continually needful to the life of animals. *Paracelſus* indeed tells us, *That as the ſtomach concocts meat, and makes part of it uſeful to the body, rejecting the other part; ſo the lungs conſume part of the air, and proſcribe the reſt.* So that, according to our Hermetick philoſopher, (as his followers would have him ſtyled) it ſeems we may ſuppoſe, that there is in the air a little vital quinteſſence (if I may ſo call it) which ſerves to the refreſhment and reſtauration of our vital ſpirits, for which uſe the groſſer and incomparably greater part of the air being unſerviceable, it need not ſeem ſtrange, that an animal ſtands in need of almoſt inceſſantly drawing in freſh air. But though this opinion is not (as ſome of the ſame author) abſurd, yet beſides that it ſhould not be barely aſſerted, but explicated and proved; and beſides that ſome objections may be framed againſt it, out of what hath been already argued againſt the tranſmutation of air into vital ſpirits: beſides theſe things, it ſeems not probable, that the bare want of the generation of the wonted quantity of vital ſpirits, for leſs than one minute, ſhould, within that time, be able to kill a lively animal, without the help of any external violence at all.

BUT yet, on occaſion of this opinion of *Paracelſus*, perhaps it will not be impertinent if, before I proceed, I acquaint your Lordſhip with a conceit of that deſervedly famous Mechanician and Chymiſt, *Cornelius Drebell*, who, among other ſtrange things that he perform'd, is affirm'd, by more than a few credible perſons, to have contrived, for the late learned King *James*, a veſſel to go under water; of which, trial was made in the *Thames*, with admired ſucceſs, the veſſel carrying twelve rowers, beſides paſſengers; one of which is yet alive, and related it to an excellent Mathematician that informed me of it. Now that for which I mention this ſtory is, that having had the curioſity and opportunity to make particular inquiries among the relations of *Drebell*, and eſpecially of an ingenious Phyſician that married his daughter, concerning the grounds upon which he conceived it feaſible to make men unaccuſtomed to continue ſo long under water without ſuffocation, or (as the lately mentioned perſon that went in the veſſel affirms) without inconvenience; I was anſwered, that *Drebell* conceived, that it is not the whole body of the air, but a certain quinteſſence (as Chymiſts ſpeak) or ſpirituous part of it, that makes it fit for reſpiration; which being ſpent, the remaining groſſer body, or carcaſe, if I may ſo call it, of the air, is unable to cheriſh the vital flame reſiding in the heart: ſo that, for aught I could gather, beſides the mechanical contrivance of his veſſel, he had a chymical liquor, which he accounted the chief ſecret of his ſubmarine navigation. For when, from time to time, he perceived that the finer and purer part of the air was conſumed, or over-clogged by the reſpiration and ſteams of thoſe that went in his ſhip, he would, by unſtopping a veſſel full of this liquor, ſpeedily reſtore to the troubled air ſuch a proportion of vital parts, as would make it again, for a good while, fit for reſpiration, whether by diſſipating, or precipitating the groſſer exhalations, or by ſome other intelligible way, I muſt not now ſtay to examine; contenting my ſelf to add, that having had the opportunity to do ſome ſervice to thoſe of his relations that were moſt intimate with him, and having made it my buſineſs to learn what this ſtrange liquor might be, they conſtantly affirmed that *Drebell* would never diſcloſe the liquor unto any, nor ſo much as tell the matter whereof he had made it, to above one perſon, who himſelf aſſured me what it was.

THIS account of *Drebell*'s performance I mention, not that I any farther aſſent to opinion than I have already intimated, but becauſe the man and the invention being extraordinary, I ſuppoſe your Lordſhip will not be diſpleaſed to know the utmoſt I could learn about it; eſpecially not having found it mentioned by any writer. Wherefore I have been ſometimes inclined to favourable thoughts of their opinion, who would have the air neceſſary to ventilate and cheriſh the vital flame, which they do ſuppoſe to be continually burning in the heart. For we ſee, that in our engine the flame of a lamp will laſt almoſt as little after the exſuction of the air, as the life of an animal: nay, I remember that though I deviſed a more promiſing way to make a fire laſt in our exhauſted receiver, yet it would not

ſucceed. We took a hard body made in the form of a clove, but twice as long, and proportionably thick; this body being made of ſuch a compoſition, that if it be kindled at the upper end, it will moſt certainly burn away to the very bottom, much better than a match; we conveyed it divers times, kindled at the upper end, into one of our ſmall receivers, but ſtill found, that though preſently upon the exſuction of the air, it would leave ſmoking, and ſeem quite gone out, and again begin to ſmoke as ſoon as the air was let in upon it; yet if the air were kept out but four or five minutes, the fire would be totally and irrevocably extinguiſhed. To which we will add, that though we conveyed into a great receiver a ſmall lamp with rectified ſpirit of wine, that being ſo pure as not to ſmut the cotton wiek, or ſo much as a piece of white paper held over it; yet we could not by divers trials make the flame laſt a couple of minutes, after the air was begun to be drawn out. But though our engine thus ſhews us a new kind of reſemblance betwixt fire and life, yet the opinion we have laſt mentioned is not free from difficulties. For, though in the hearts of many animals, blood be a warm liquor, and in ſome even a hot one; yet it is not eaſy to conceive either how the air (in ſubſtance) can get thither, or how, in caſe it could, it were able to increaſe the heat. Since, however, the air may increaſe the heat of a coal by blowing off the aſhes, and making the active corpuſcles pierce farther into the kindled body, and ſhatter it the more; yet we ſee hot liquors have their heat allayed, and not augmented, by having air blown on them. And whereas ſome eminent Naturaliſts think it not inconvenient to make the heat reſiding in the heart to be a true flame, provided they add, that it is ſuch a temperate and almoſt inſenſible fire, as the flame of ſpirit of wine, which will long burn upon fine white linen or paper without conſuming either; give me leave to wiſh that they had been more curious to make differing trials with that liquor. For (as we obſerve in another treatiſe) the reaſon why a linen cloth, dipped in common ſpirit of wine, is not burnt by the flame of it, is, becauſe the phlegm of the liquor defends the cloth: and the flame of ſpirit of wine is ſo far from being too weak to burn a piece of paper, or of linen, that I have uſed it in lamps to diſtil liquors out of tall cucurbites, and found that the ſpirit burned away indeed much faſter than ſallad oil, but gave at leaſt as great a heat: nay, I have, for curioſity ſake, melted crude gold, and that readily enough, with the bare flame of pure ſpirit of wine.

BUT not to preſs this any farther, we will, on this occaſion, venture to ſubjoin an odd obſervation, which may perhaps invite to a farther inquiry into the opinion we have for diſcourſe ſake oppoſed. Our Engliſh *Democritus*, Dr. *Harvey*, propoſeth this difficult and noble problem to Anatomiſts, *Why a fœtus, even out of the womb, if involved in the ſecundines, may live a good while without reſpiration; but in caſe after having once began to breathe, its reſpiration be ſtopped, it will preſently die?* We are far from pretending to ſolve ſo hard a problem, but this we tried in relation to it: We took a bitch that was ſaid to be almoſt ready to whelp, and having cauſed her to be hanged, we preſently opened her abdomen, and found four puppies in her womb; one of theſe we took out, and having freed him from the teguments that involved him, and from the liquor he ſwam in, we obſerved that he quickly opened his mouth very wide, moved his tongue, and exerciſed reſpiration. Then we opened both his abdomen and his cheſt, and cut aſunder the diaphragm, notwithſtanding which, he ſeemed often to endeavour reſpiring, and moved in a notable manner, both the intercoſtal muſcles, part of the diaphragm, the mouth and the tongue. But that which we mention this puppy for, was this, that being deſirous to try whether the other young ones, that had not yet breathed at all, would long ſurvive this or no; we took them alſo out of the womb, and having opened them, found none of them ſo much alive, as to have any perceptible motion in his heart; whereas the heart of that puppy which had once enjoyed the benefit of reſpiration continued beating ſo long, that we ourſelves obſerved the auricle to beat, after five or ſix hours; and a ſervant that ſtaid up and watched it after we were gone to bed, affirmed, that he ſaw the pulſation continue about two hours longer. I ſhall leave it to others to make reflexions upon this obſervation, compared with Dr *Harvey's* problem.

IT is much doubted, whether fiſhes breathe under water, and we ſhall not take upon us, as yet, to determine the queſtion either way, becauſe we have not yet been able to procure little fiſhes alive to make experiments upon. That ſuch as are not ſetaceous (for ſuch manifeſtly breathe) have not reſpiration, properly ſo called, ſuch as is exerciſed by four-footed beaſts, and birds, may be argued from their having no cavity in their hearts, and from their want of lungs, whence they are obſerved to be mute; unleſs we ſay, what is not altogether abſurd, that their gills ſeem ſomewhat analogous (as to their uſe) to lungs. But that, on the other ſide, air is neceſſary to the lives even of fiſhes, and that therefore it is probable they have ſome obſcure kind of reſpiration, ſeems manifeſt by two or three obſervations and experiments, mentioned by divers authors, who tell us, *that fiſhes ſoon die in ponds and glaſſes quite filled with water; if the one be ſo frozen over, and the other ſo cloſely ſtopped, that the fiſhes cannot enjoy the benefit of the air*; if we allow them to be true. But becauſe theſe relations are not wont to be delivered by writers upon their own knowledge; as I ſhall not reject them, ſo I dare not build upon them, till I have opportunity to examine them by experience. In the mean time, we will add, that our engine hath taught us two things that may illuſtrate the matter in hand: the one, that there is wont to lurk in water many little parcels of interſperſed air, whereof it ſeems not impoſſible that fiſhes

may

may make ſome uſe, either by ſeparating it, when they ſtrain the matter thorow their gills, or by ſome other way: the other, what may be collected from the following experiment.

We took a large eel, (being able to procure no other fiſh alive) and removing it out of the veſſel of water, wherein it was brought us, into our great receiver, we cauſed the air to be pumped out; and obſerved, that the eel, after ſome motion to and fro in the glaſs, ſeemed ſomewhat diſcompoſed; and that when we had proſecuted the exſuction of the air ſomewhat obſtinately, ſhe turned up her belly, as dying fiſhes are wont to do, and from thence-forward lay altogether moveleſs, juſt as if ſhe were ſtark dead; and though I did not think her ſo, yet the continuing in that poſture, even after the cover of the receiver was taken off (whereby the air was let in) I ſhould have been of the opinion of the by-ſtanders, if the diffidence I am wont to exerciſe in trying experiments (eſpecially ſuch as are not uſual) had not invited me to take the fiſh out of the receiver; upon which ſhe ſhewed herſelf, by her vivid motions, as much alive as before.

But that is moſt ſtrange which we obſerved of a great, grey houſe-ſnail (as they call it) which being cloſed up in one of our ſmall receivers, did not only not fall down from the ſide of the glaſs, upon the drawing out of the air; (for that may be aſcribed to the tenacity of the liquor wherewith ſnails uſe to ſtick themſelves, even to the ſmootheſt bodies:) but was not ſo much as deprived of progreſſive motion by the receſs of the air; though, except this ſnail, we never put any living creature into our receiver, whom it did not kill, or at leaſt reduce to ſeem ready to die. But as we ſhall not here examine what intereſt the glutinous, and uneaſily diſſipable nature of the juices of ſnails may have on this event; ſo whether this eſcape of our eel be aſcribed to the particular and vivacious nature of this ſort of fiſhes, or to this, that the air is not indeed neceſſary to the life of fiſhes; or finally to this, that though theſe animals need ſome air, yet they need ſo little, that that which could not be drawn out of the receiver might (at leaſt for a while) ſuffice them, we will not now determine.

Nor are we at leiſure to examine that paradox of *Hippocrates*, which ſome learned phyſicians have of late revived, namely, that the fœtus reſpires in the womb. For, on the one ſide, it ſeems very difficult to conceive, how air ſhould traverſe the body of the mother, and the teguments of the child: And ſince nature hath, in new-born babes, contrived peculiar and temporary veſſels, that the blood may circulate thorough other paſſages, than it is wont to do in the ſame individuals when they come to have the free uſe of their lungs; it ſeems unlikely that infants in the womb do properly reſpire. But then ſince our experiments have manifeſted, that almoſt all kinds of liquors do, as well as water, abound with interſperſed corpuſcles of air, it ſeems not altogether abſurd to ſay, that when the fœtus is grown big, he may (eſpecially the upper part of the involving amnios being deſtitute of liquor, and filled only with an halituous ſubſtance) exerciſe ſome obſcure reſpiration; eſpecially, ſince it is not (as many wiſe men think it) a fable, that children have been heard to cry in the mother's womb; for though it happens exceeding rarely, yet ſometimes it hath been obſerved. And I know a young lady, whoſe friends, when ſhe was ſome years ſince with child, complained to me, that ſhe was ſeveral times much frighted with the cries of her infant, which, till I diſabuſed her, ſhe and her friends looked upon as portentous. And ſuch obſervations are the more credible, becauſe not only houſewives, but more judicious perſons, mention it as no very unfrequent thing, to hear the chick pip and cry in the egg, before the ſhell be broken. But this I mention but as a probable, not a cogent argument, till I can diſcover whether an eliſion of an halituous ſubſtance, though no true air, may not at the top of the larynx produce a ſound; ſince I find that the blade of a knife, held in ſeveral poſtures in the ſtream of vapours (or rarefied water) that iſſues out of an æolipile, will afford various and very audible ſounds.

I Had thoughts of conveying into our receiver young ones, ripped out of the womb of their dams, with their involving coats intire, but could not procure them. And I have alſo had thoughts of trying whether it be not practicable to make a receiver, though not of glaſs, yet with little glaſs windows, ſo placed, that one may freely look into it, capacious enough to hold a man, who may obſerve ſeveral things, both touching reſpiration, and divers other matters; and who, in caſe of fainting, may, by giving a ſign of his weakneſs, be immediately relieved, by having air let in upon him. And it ſeems not impoſſible, but that by accuſtomance, ſome men may bring themſelves to ſupport the want of air a pretty while, ſince we ſee that divers will live, ſo much longer than other men, under water; that thoſe that dive for pearls in the *Weſt Indies* are ſaid to be able to ſtay a whole hour under water: and *Cardan* tells us of one *Colanus* a diver in *Sicily*, who was able to continue (if *Cardan* neither miſtake nor impoſe upon us) three or four times as long. Not to mind your Lordſhip, that you have your ſelf oftentimes ſeen in *England* a corpulent man, who is wont to deſcend to the bottom of the *Thames*, and bring out of deep holes, at the bottom of the banks, large fiſhes alive in his hands. And *Acoſta* tells us, he ſaw in *Peru* the like manner of fiſhing, but more difficult, practiſed by the *Indians*.

I Made mention of ſome men, and of accuſtomance; becauſe there are but very few, who, though they uſe themſelves to it by degrees, are fit to ſupport, for many minutes, the want of air. Inſomuch that an ingenious man of my acquaintance, who is very famous for the uſeful ſkill of drawing goods, and even ordnance, out of ſunk ſhips, being aſked by me how long he was able to continue at the depth of 50 or 60 foot under water, without the uſe of reſpiration, confeſſed to me, that he cannot continue above two minutes of an hour, without reſorting to the air, which he carries down with him in a certain engine, (whereof I

can

can ſhow your Lordſhip a deſcription.) Another thing I alſo learned of him by inquiry, that was not deſpicable: For aſking him, whether he found any uſe of chawing little ſponges, dipt in oil, in his mouth, when he was perfectly under water, and at a diſtance from his engine; he told me, that by the help of theſe ſponges he could much longer ſupport the want of his wonted reſpiration, than he was able to do without them. The true cauſe of which would perhaps, if diſcovered, teach us ſome thing pertinent to the problem touching the reſpiration of fiſhes.

BUT the neceſſity of air to the moſt part of animals unaccuſtomed to the want of it, may beſt be judged of, by the following experiments, which we tried in our engine, to diſcover, whether inſects themſelves have not, either reſpiration, or ſome other uſe of the air equivalent thereunto.

WE took then an humble bee, one of thoſe common flies that are called fleſh-flies, and one of thoſe hairy worms that reſemble caterpillars, and are wont to be called palmer worms: theſe three we conveyed into one of our ſmall receivers, and obſerved, to the great wonder of the beholders, that not only the bee, and the fly fell down, and lay with their bellies upwards, but the worm itſelf ſeemed to be ſuddenly ſtruck dead; all of them being reduced to lie without motion, or any other diſcernable ſign of life, within ſomewhat leſs (if we miſtake not) than one minute of an hour; and this, notwithſtanding the ſmallneſs of the animals in proportion to the capacity of the veſſels. Which circumſtance we the rather mention, becauſe we found that the veſſel was not free from leaks. And to ſatisfy the ſpectators, that it was the abſence of the air that cauſed this great and ſudden change; we had no ſooner re-admitted the air at the ſtop-cock, than all the three inſects began to ſhew ſigns of life, and by little and little to recover. But when we had again drawn out the air, their motions preſently ceaſed, and they fell down ſeemingly dead as before, continuing moveleſs, as long as, by continuing to pump, the veſſel was kept exhauſted. This invited us thankfully to reflect upon the wiſe goodneſs of the creator, who by giving the air a ſpring, hath made it ſo very difficult, as men find it, to exclude a thing ſo neceſſary to animals: And it gave us alſo occaſion to ſuſpect, that if inſects have no lungs, nor any part analogous thereunto, the ambient air affects them, and relieves them at the pores of their ſkin; it not being irrational to extend to theſe creatures that of *Hippocrates*, who ſaith, that a living body is throughout perſpirable; or, to uſe his expreſſion, εἰσπνεῖν δὲ ἐκπνεῖν, diſpoſed to admit and part with what is ſpirituous. Which may be ſomewhat illuſtrated by what we have elſewhere noted, that the moiſter parts of the air readily inſinuate themſelves into, and recede from the pores of the beards of wild oats, and thoſe of divers other wild plants; which almoſt continually wreath and unwreath themſelves according to, even, the light variations of the temperature of the ambient air.

THIS circumſtance of our experiment we particularly took notice of, that when at any time, upon the ingreſs of the air, the bee began to recover, the firſt ſign of life ſhe gave, was a vehement panting, which appeared near the tail; which we therefore mention, becauſe we have obſerved the like in bees drowned in water, when they firſt come to be revived by a convenient heat: As if the air were in the one caſe as proper to ſet the ſpirits and alimental juice moving, as heat is in the other; and this may, perchance, deſerve a farther conſideration.

WE may add, that we ſcarce ever ſaw any thing that ſeemed ſo much as this experiment to manifeſt, that even living creatures (man always excepted) are a kind of curious engines, framed and contrived by nature (or rather the author of it) much more ſkilfully than our groſs tools and imperfect wits can reach to. For in our preſent inſtance we ſee animals, vivid and perfectly ſound, deprived immediately of motion, and any diſcernable ſigns of life, and reduced to a condition that differs from death, but in that it is not abſolutely irrecoverable. This (I ſay) we ſee performed without any, ſo much as the leaſt external violence offered to the engine; unleſs it be ſuch as is offered to a wind-mill, when the wind ceaſing to blow on the ſails, all the ſeveral parts remain moveleſs and uſeleſs, till a new breath put them into motion again.

AND this was farther very notable in this experiment; that whereas it is known that bees and flies will not only walk, but fly for a great while, after their heads are off; and ſometimes one half of the body will, for divers hours, walk up and down, when it is ſever'd from the other: yet, upon the exſuction of the air, not only the progreſſive motion of the whole body, but the very motions of the limbs do forthwith ceaſe; as if the preſence of the air were more neceſſary to theſe animals, than the preſence of their own heads.

BUT, it ſeems, that in theſe inſects, that fluid body (whether it be a juice or flame) wherein life chiefly reſides, is nothing near ſo eaſy diſſipable as in perfect animals. For whereas we have above recited, that the birds we conveyed into our ſmall receiver were within two minutes brought to be paſt recovery, we were unable (though by tiring him that pumped) to kill our inſects by the exſuction of the air: for though, as long as the pump was kept moving, they continued immoveable, yet, when he deſiſted from pumping, the air that preſſed in at the unperceived leaks did, though ſlowly, reſtore them to the free exerciſe of the functions of life.

BUT, my Lord, I grow troubleſome, and therefore ſhall paſs on to other experiments: yet without deſpairing of your pardon for having entertained you ſo long about the uſe of reſpiration, becauſe it is a ſubject of that difficulty to be explained, and yet of that importance to human life, that I ſhall not regret the trouble my experiments have coſt me, if they be found in any degree ſerviceable to the purpoſes to which they were deſigned. And though

I deſpair not but that hereafter our engine may furniſh us with divers phænomena uſeful to illuſtrate the doctrine of reſpiration; yet having not, as yet, had the opportunity to make the other trials, of various kinds, that I judge requiſite for my information, I muſt confeſs to your Lordſhip, that in what I have hitherto ſaid, I pretend not ſo much to eſtabliſh or overthrow this or that hypotheſis, as to lay together divers of the particulars that occurred to me, in order to a future inquiry. I ſay, divers of the particulars, becauſe I could add many others, but that I want time, and fear that I ſhould need your Lordſhip's pardon for having been ſo prolix in writing; and that of Phyſicians (which perhaps I ſhall more eaſily obtain) for having invaded anatomy, a diſcipline which they challenge to themſelves, and indeed have been the almoſt ſole improvers of. Without denying then, that the inſpired and exſpired air may be ſometimes very uſeful, by condenſing and cooling the blood that paſſeth through the lungs; I hold that the depuration of the blood in that paſſage, is not only one of the ordinary, but one of the principal uſes of reſpiration. But I am apt alſo to ſuſpect, that the air doth ſomething elſe in reſpiration, which hath not yet been ſufficiently explained; and therefore, 'till I have examined the matter more deliberately, I ſhall not ſcruple to anſwer the queſtions that may be aſked me, touching the genuine uſe of reſpiration, in the excellent words employed by the acute St. *Auſtin*, to one who aſked him hard queſtions: *Mallem quidem* (ſays he) *eorum quæ à me quæſiviſti, habere ſcientiam quam ignorantiam: ſed quia id nondum potui, magis eligo cautam ignorantiam confiteri, quam falſam ſcientiam profiteri.*

EXPERIMENT XLII.

HAVING (partly upon the conſideration of ſome of the foregoing experiments, and partly upon grounds not now to be inſiſted on) entertained a ſuſpicion, that the action of corroſive liquors in the diſſolving of bodies may be conſiderably varied by the gravitation or preſſure of the incumbent air, and the removal of it; I thought fit to examine my conjecture by the following experiment.

I TOOK whole pieces of red coral, and caſt them into as much ſpirit of vinegar, as ſufficed to ſwim above an inch over them: theſe ſubſtances I made choice of, that the ebullition upon the ſolution might not be too great, and that the operation might laſt the longer.

HAVING then put about half a ſcore ſprigs of coral, together with the menſtruum, into a ſomewhat long-necked phial, whereof they ſeemed ſcarce to fill a third part, we conveyed that phial into one of our ſmall pneumatical glaſſes, containing by gueſs about a quart of water; and having faſtened on the cover, after the accuſtomed manner, we ſuffered the liquor to remain unmoved a while, to obſerve whether the menſtruum would work upon the coral otherwiſe than before. But finding there did only ariſe, as formerly, a pretty number of ſmall bubbles, that made there no ſenſible froth upon the ſurface of the diſtilled vinegar, there were made two or three exſuctions of the air; upon which, there emerged from the coral ſuch a multitude of bubbles, as made the whole body of the menſtruum appear white; and ſoon after a froth, as big as all the reſt of the liquor, was ſeen to ſwim upon it; and the menſtruum plainly appeared to boil in the glaſs, like a ſeething-pot. And though, if we deſiſted but one minute from pumping, the decrement of the froth and ebullition, upon the getting in of a little air, at ſome leak or other, ſeemed to argue, that the removal of the preſſure of the external air was the cauſe, or, at leaſt, the occaſion of this effervescence; yet to evince this the more clearly, we turned the key, and let in the external air at the ſtop-cock: immediately upon whoſe entrance, the froth vaniſhed, and ſo many of the bubbles within the body of the liquor diſappeared, that it loſt its whiteneſs, and grew tranſparent again; the menſtruum alſo working as languidly upon the coral, as it did before they were put into the receiver. But when we had again drawn out the air, firſt the whiteneſs re-appeared, then the ebullition was renewed, which (the pumping being a while longer, and nimbly purſued) grew ſo great, that for three or four times one after another, whenever the air was let out of the receiver into the emptied cylinder, the frothy liquor overflowed the glaſs, and ran down by the ſides of it; and yet, upon the re-admitting of the excluded air, the boiling liquor grew immediately as calm and as tranſparent as at firſt: as if indeed the operation of it, upon the coral, had been facilitated by the exſuction of the incumbent air, which on its receſs left it more eaſy for the more active parts of the liquor to ſhew themſelves ſuch, than it was whilſt the wonted preſſure of the air continued unremoved. It may indeed be ſuſpected, that thoſe vaſt and numerous bubbles proceeded not from the action of the menſtruum upon the coral, but from the ſudden emerſion of thoſe many little parcels of air that (as we formerly obſerved) are wont to be diſperſed in liquors, without excluding ſpirit of vinegar: but having had this ſuſpicion before we tried the experiment, we conveyed our diſtilled vinegar alone into the receiver, and kept it a while there, to free it from its bubbles (which were but very ſmall) before ever we put the coral into it. It may be ſuſpected likewiſe, that the agitation of the liquor, neceſſarily following upon the ſhaking of the glaſs, by pumping, might occaſion the recited ebullition; but upon trial made, there appeared not any notable change in the liquor, or its operation, though the containing veſſel were ſhaken, provided no air were ſucked out of it. The former experiment was another time tried in another ſmall receiver, with coral groſly powdered, and the ſucceſs was very much alike, ſcarce differing in any thing, but that the coral being reduced to ſmaller parts, upon the ebullition of the liquor, ſo many little lumps of coral would be carried and buoyed up by the emerging bubbles, as ſometimes to darken the phial, though the ſame coralline corpuſcles would

be let fall again upon the letting in of the air.

SOMETHING alſo we tried in our great receiver, concerning the ſolution of metals in aqua fortis, and other corroſive liquors; but partly the ſtink, and partly ſome accidents, kept us from obſerving any thing peculiar and remarkable about thoſe ſolutions.

ONE thing we muſt not omit, that when the ſpirit of vinegar was boiling upon the coral, we took off the cover of the receiver, and took out the phial, but could not find, that, notwithſtanding ſo very late an ebullition, the liquor had any heat great enough to be at all ſenſible to our hands.

EXPERIMENT XLIII.

WE will now ſubjoin an experiment, which, if the former did not leſſen, the wonder of it would probably appear very ſtrange to your Lordſhip, as it did to the firſt ſpectators of it.

THE experiment was this: We cauſed water to be boiled a pretty while, that by the heat it might be freed from the latitant air, ſo often already taken notice of in common water. Then almoſt filling with it a glaſs phial, capable of containing near four ounces of that liquor; we conveyed it, whilſt the water was yet hot, into one of our ſmall receivers, (big enough to hold about a pound of water) and having luted on the cover, we cauſed the air to be drawn out. Upon the two firſt exſuctions, there ſcarce appeared any change in the liquor, nor was there any notable alteration made by the third; but at the fourth, and afterwards, the water appeared to boil in the phial, as if it had ſtood over a very quick fire; for the bubbles were much greater than are uſually found upon the ebullition of very much more water than was contained in our phial. And this efferveſcence was ſo great in the upper part of the water, that the liquor boiling over the top of the neck, a pretty deal of it ran down into the receiver, and ſometimes continued (though more languidly) boiling there. Proſecuting this experiment, we obſerved, that ſometimes, after the firſt ebullition, we were reduced to make divers exſuctions of the air, before the liquor would be brought to boil again. But at other times, as often as the key was turned to let the air paſs from the receiver into the pump, the efferveſcence would begin afreſh, though the pump were plied for a pretty while together; which ſeemed to argue, that the boiling of the water proceeded from hence, That upon the withdrawing the preſſure of the incumbent air, either the firy corpuſcles, or rather the vapours agitated by the heat in the water, (which laſt, what we have formerly noted touching the rarefied water of an æolipile, manifeſt to be capable of an elaſtical power) were permitted to expand themſelves mightily in the evacuated receiver; and did, in their tumultuous dilatation, lift up (as the air is wont to do) the uppermoſt part of the water, and turning it into bubbles, made the water appear boiling. This conjecture was farther confirmed by theſe additional circumſtances: firſt, the efferveſcence was confined to the upper part of the water, the lower remaining quiet, unleſs the liquor were but ſhallow. Next, although ſometimes (as is already noted) the ebullition began again, after it had ceaſed a pretty while, which ſeemed to infer, that ſome concurrent cauſe (whatever that were) did a little modify the operation of heat; yet, when the water in the phial could by no pumping be brought to boil any more, the ſelf-ſame water, being in the very ſame phial warmed again and reconveyed into the pneumatical glaſs, was quickly brought to boil afreſh, and that vehemently and long enough; not to mention, that a new parcel, taken out of the ſame parcel of the boiled water with the former, and put in cold, could by no pumping be brought to the leaſt ſhew of efferveſcence. Beſides, having tried the experiment in hot ſallad-oil, being a much more tenacious liquor, and requiring a ſtronger heat to make it boil, could not be brought to an efferveſcence in our receiver; whereas the chymical oil of turpentine, being thinner and more volatile, was preſently made to boil up, till it reached four or five times the former height in the phial, in whoſe bottom it lay, and continued boiling till it was almoſt reduced to be but luke-warm. Wine alſo being a more thin and ſpirituous liquor than water, being conveyed in hot, inſtead of the oil, did, as I remember, at the very firſt exſuction begin to boil ſo vehemently, that, in a ſhort time that the pump was kept moving, four parts of five, by our gueſs, boiled over out of the phial, though it had a pretty long neck. On which occaſion we will add, that even the water it ſelf, near one half, would ſometimes boil over into the receiver before it became luke-warm. And it was alſo remarkable, that once, when the air had been drawn out, the liquor did, upon a ſingle exſuction, boil ſo long with prodigiouſly vaſt bubbles, that the efferveſcence laſted almoſt as long as was requiſite for the rehearſing of a *Pater noſter*. Now the experiment having been tried more than once, and found to ſucceed as to the main, ſeems much to countenance the conjecture we made at the beginning of this letter, where we told your Lordſhip, that perhaps the preſſure of the air might have an intereſt in more phænomena than men have hitherto thought. For as we had not then made this experiment, ſo now we have made it, it ſeems to teach, that the air, by its ſtronger or weaker preſſure, may very much modify (as the ſchoolmen ſpeak) divers of the operations of that vehement and tumultuous agitation of the ſmall parts of bodies, wherein the nature of heat ſeems chiefly, if not ſolely, to conſiſt. Inſomuch that if a heated body were conveyed above the atmoſphere, it is probable that the heat may have a differing operation, as to the power of diſſipating the parts of it, from what it hath here below.

TO conclude; This experiment might have been farther proſecuted, but our want of leiſure makes us content our ſelves to add at preſent, that perhaps it would not be loſt labour if this were

were tried, not only with other liquors, but with variety of heated, and especially soft or melted bodies: but in such cases the receiver ought to be shaped, as is most proper to preserve the cement wherewith the cover must be fastened on, from being melted by the heat of the included matter; the inconvenience to be hereby avoided, having befallen us in the use of a receiver too shallow, though otherwise capacious enough.

The CONCLUSION.

BEING come thus far, my dear Lord, not without thoughts of proceeding farther; the unwelcome importunity of my occasions becomes so prevalent, that it quite hinders, for the present, my designed progress; and reduceth me, not only to reserve for another opportunity that kind of experiments, which, at some distance from the beginning of this letter, I called (as your Lordship may remember) experiments of the second sort; but to leave unessayed some of the first sort, which I might try in the engine, as it now is, were it not that my avocations are grown so urgent, for my remove from the place where the engine was set up, that I am put to write your Lordship this excuse: Weary, and in an inn which I take in my way to my dearest brother *Corke*; who being at length arrived in *England*, after I have for divers years been deprived of his company, and wished for it as long; whatever my other occasions may be, my first business must be to wait on him and your excellent mother; in whose grateful company I may hope to forget a while those publick calamities that distress this too unhappy nation; since that is indeared to me, both by their personal merit; by the near relation which nature gives me to him, affinity to her, and friendship to both; and also by their many favours, especially that of my owing them my *Lord of Dungarvan*. But I suffer my self to be transported too far with these delightful thoughts; to return therefore to our engine. Though I find this letter is beyond my expectation swelled, not only into a book, but almost into a volume; yet the experiments already mentioned in it, are so far from comprising all those that may be tried by the help of our engine, that I have not yet been able to try all those, which, presently occurring to my thoughts, upon my first seeing the working of it, I caused to be set down in a catalogue within less than half an hour. But I doubt I have but too much cause to apprehend that the affairs and other things I complain of, have made it needful for me to apologize, as well for the things I have set down, as for those I am necessitated to omit. For as partial as men use to be to the children of their own brains, as well as to those of their loins, I must not deny that the foregoing trials are not altogether free from such unaccurateneſſes, nor the recital of them from such imperfections, as I my self can now discern, and could, perhaps, partly mend, if I had the leisure to repeat the experiments, with the circumstances that have since offered themselves to my thoughts, as things that might have been worth observation or inquiry. But the truth is, that I was reduced to make these experiments, when my thoughts had things that more concerned me to imploy them, and the same avocations made me set them down, for the most part, as soon as I had made them, and in the same order, and that so fast, that I had not overfrequently the opportunity to mind any more than the bare truth of what I set down; without allowing it any of those advantages that method, style, and decent embellishments, are wont to confer on the compositures they are employed to adorn.

BUT, my Lord, though to invite and encourage you and your learned friends at *Paris*, to make a farther use of this engine, than I have yet been able to do, I am thus free to acknowledge the imperfections of the foregoing letter; yet, if some intelligent persons mistake not, by what hath been done, such as it is, there is a way opened, whereby sagacious wits will be assisted to make such farther discoveries in some points of natural philosophy, as are yet scarce dreamed of. And I am the more desirous to engage you to that employment, because I am apt to think, that if the making and writing of such experiments shall cost you as much trouble as they have me, you will be inclined to excuse me; and if the discoveries give you as much pleasure as they gave me, you will (perhaps) be invited to thank me. However, I think (my Lord) I may justly pretend, that the things I have set down have been faithfully recorded, though not elaborately written: and, I suppose, my former papers may have long since satisfied you, that though many devise experiments better than your servant, none perhaps hath related them more carefully and more truly: and particularly of these, sometimes one, sometimes another, hath been performed in the presence of persons, divers of them eminent for their writings, and all for their learning. Wherefore, having in the foregoing narratives made it my business to ennoble them with the chief requisites of historical compositures, candour and truth, I cannot despair that you will either excuse their imperfections, or, at least, forgive them: especially, considering that this unpolished letter is as well a production of your Lordship's commands and my obedience, as a testimony of my desire to make others beholden to my Lord of *Dungarvan*, by the same way which I endeavour to express my self,

Beconsfield, this 20th of *December*, 1659.

His Lordship's

Most obedient Servant, and

Most affectionate Uncle,

ROBERT BOYLE.

A

DEFENCE

OF THE

DOCTRINE

Touching the

SPRING and WEIGHT of the AIR,

Propoſed by Mr. *R. BOYLE*, in his NEW PHYSICO-MECHANICAL EXPERIMENTS;

Againſt the OBJECTIONS of

FRANCISCUS LINUS.

Wherewith the Objector's FUNICULAR HYPOTHESIS is alſo Examined.

The Publiſher to the Reader.

Friendly Reader,

YOU may poſſibly in this volume have expected the Appendix which the author heretofore promiſed, and has intended ſhall contain ſome additional experiments to thoſe which were formerly publiſhed, and are here now reprinted in this ſecond edition. Theſe following anſwers to *Franciſcus Linus* and Mr. *Hobbs* are preſented in compenſation of the delay, and for your forbearance of that Appendix, which ere long you may expect in kind. For the author having hinted the promiſe, ſeems thereby to acknowledge the debt, and to be content to continue the obligation to ſee it performed. And theſe ought the rather to be his excuſe, becauſe the writing theſe anſwers, and publiſhing the *Sceptical Chymiſt*, and ſome other diſcourſes, have been the principal hindrances to that piece; which is really ſo near a readineſs, that part of it has lain at the preſs theſe ſix months: But yet it being not all perfected, the Stationer was loth to delay any longer the publication of theſe, for which he has been ſo frequently called upon. And they (though a Latin edition is intended) appear now the rather in Engliſh, that they may accompany the ſecond edition of the original experiments, which were printed firſt in that language in octavo; and that, inſtead of the promiſed Appendix, they may complete the bulk of the quarto volume.

As for that part of this piece that concerns Mr. *Hobbs*, it might have been larger: but the information that the author had, that the learned Dr. *Wallis* was writing againſt ſome paſſages in Mr. *Hobbs* his Dialogues (as well that concerning the air, as the reſt) was the occaſion why his H. would make no animadverſion on ſome paſſages therein, and thought it not fit to enlarge upon others. And for the Errata of the preſs, I hope they will not be many: however, the author as to theſe is to be excuſed, who never (in regard to his eyes and impediments on other occaſions) gives himſelf the trouble of corrections and reviſes; neither could the publiſher much attend the preſs, it being printed in a diſtant place from his uſual abode. If, as I wiſh, you ſhall find this jealouſy of mine to have been cauſleſs, you will have reaſon to give the piece that is ſo kindly offered, and leads you ſuch rare and untrodden paths in the beſt way of Natural Philoſophy, the fairer entertainment and acceptance. Farewell.

Ro. Sh.

The AUTHOR's PREFACE *and* DECLARATION.

THEY that know how indiſpoſed I naturally am to contentiouſneſs, will, I preſume, wonder to ſee me publickly engaged in two controverſies at once. But that I am ſtill as averſe as ever from entering into diſputes that may handſomly be declined, the way wherein I have managed the following controverſies will, I hope, evince. And the induce-

inducements I now have to appear in publick are ſuch, that it would be hard for me to reſiſt the being prevailed on by them.

For, in the firſt place, I was (by name, as it were) challenged by a perſon, who undertook to diſprove not one or two of my conjectures, but as much of the whole body of my treatiſe as concerned the ſpring of the air, which moſt of my explications ſuppoſe. And this being done by a learned man, who writes very confidently of the goodneſs of his hypotheſis and arguments, and his book being ſoon after followed by another written by Mr. *Hobbs*, a man of name in the world; there ſeemed to be ſome danger that ſo early an oppoſition might oppreſs the doctrine I had propoſed, before it was well underſtood and duly pondered. Wherefore I feared I might be wanting to the truth and myſelf, if I ſhould at ſuch a time be altogether ſilent; eſpecially ſince I might probably divert many who would otherwiſe be forward to appear againſt us, by letting them ſee how defenſible our doctrine is, even againſt ſuch adverſaries as thoſe I have replied to. And this courſe I the rather choſe, that in caſe I ſhould henceforward comply with thoſe who would have me forbear to write any further of theſe controverſies, it might not be preſently inferred from my ſilence, that a good cauſe cannot enable a pen no better than mine to defend it.

But I ſcarce doubt but that intelligent readers, eſpecially thoſe that are imbued with the principles of the Corpuſcularian philoſophy, will be much more apt to think that I had reaſon to write the following diſcourſes, than to think that I had any to make them ſo prolix: and eſpecially ingenious men, that are accuſtomed to admit nothing that either is not intelligible, or is precarious, will think divers of the objections I reply to, have needed no anſwers, or at leaſt no ſolemn ones. But to theſe I have four things to repreſent.

And firſt, that which not a little ſwells the bulk of the following treatiſes, is the inſerting thoſe paſſages of my adverſaries that I examine in their own words: which being a practice that I expect from any that ſhall think fit to animadvert upon any opinion or argument of mine; I thought it but equitable to do what I deſired to have done to me, though oftentimes I could not do it in a little room.

Next, I was the more willing to proſecute ſome of *Franciſcus Linus* his objections, becauſe the fear of being reduced to grant a vacuum has ſo prevailed with many eminent perſons bred up in the received philoſophy of the ſchools, that though they diſagree both with him and among themſelves about the particular manner of ſolving the phænomena of the Torricellian experiment; yet they agree in aſcribing them to ſome extremely rarefied ſubſtance, that fills up the ſpace deſerted by the quickſilver. So that this opinion, as to the main, being approved of by many eminent ſcholars, eſpecially of that moſt learned order of the Jeſuits, (to whom perhaps its congruity to ſome articles of their religion chiefly recommends it) I was willing to pay them that reſpect, as not to diſſent from perſons, divers of whom for their eminence in mathematicks and other learning I much eſteem, without ſhewing that I do it not but upon conſiderations that I think weighty.

Thirdly, though the examiner's hypotheſis have but few, and not very conſiderable arguments, to countenance it; yet his objections againſt our doctrine (the reply to which takes up the firſt part of the following treatiſe) are ſuch, as though they may be ſolidly anſwered by any that throughly underſtands our hypotheſis, yet they may chance to puzzle ſuch readers as do not, and theſe poſſibly will prove more than a few.

And laſtly, becauſe that ſometimes when the argument objected did not perhaps deſerve to be much inſiſted on, the argument treated of deſerved to be conſidered; I thought it not amiſs to make uſe, now and then, of ſome ſuch opportunities to illuſtrate the matter it ſelf under conſideration: which I the rather did, for theſe two reaſons.

First, becauſe I find that, except by ſome able Mathematicians and very few other contemplative men, the doctrine of the ſpring of the air, at leaſt as I have propoſed it, is not yet ſufficiently apprehended, (and therefore needs to be inculcated.) Inſomuch that through a great part of ſome late diſcourſes of men otherwiſe eminently learned, (written againſt other Elateriſts, not me) there ſeems to run ſo great and clear a miſtake, perhaps for want of ſkill in the Hydroſtaticks, that I can ſcarce impute it to any thing but to their not throughly underſtanding the hypotheſis they would confute.

And next, becauſe I was willing to lay down in my anſwer to the objections I examined, the grounds of anſwering ſuch other arguments as may be built upon the ſame or the like principles. And perhaps I may truly enough ſay, that in the following treatiſe I have already, in effect, anſwered ſeveral diſcourſes, written ſome before and ſome ſince mine, by learned men, about the Torricellian and other new experiments relating to a vacuum, though I forbore to mention the names or words of the authors, becauſe I found not that my writings or experiments were as yet known to them. To theſe things I may add, that I thought the diſcourſes of *Linus* the fitter to be inſiſted on, becauſe he ſeems to have more diligently than ſome others, (who yet venture to diſpute againſt it) inquired into our doctrine. And I ſhall not ſcruple to ſay thus much of an adverſary, (and one to whom I gave no provocation to be ſo) that though I dare not ſpeak in general of thoſe that have written, either about the weight of the air, or elſe for or againſt a vacuum, becauſe (as I acknowledge in the firſt chapter following) I cannot yet procure the books of divers learned men, eſpecially of thoſe great perſonages, *Robervall*, *Baliānus* and *Caſatus*; yet among the writers I have hitherto met with, who have recourſe to the Ariſtotelian rarefaction and condenſation in the controverſies under debate, ſcarce any ſeems to have contrived his hypotheſis better than our *Linus*. Not that I think his principle is either true, or (at

leaſt to ſuch as I) intelligible; but that the Funiculus he aſſumes being allowed him, he may, for a reaſon to be touched a little below, make out, though not all the phænomena of my experiments, yet many more of them than moſt other Pleniſts, that deny the ſpring of the air, can deduce from their hypotheſis if granted. And in regard that, whereas we aſcribe to the air a motion of reſtitution outwards, he attributes to it the like motion inwards, it cannot but happen that, though the principles cannot both be true, yet many of the phænomena may be explicable by which of them ſoever is granted: becauſe of this, I ſay, it is not ſo eaſy as many ingenious readers may be apt to think, to draw pertinent objections from experience againſt the adverſary I have to deal with. Which I repreſent, leſt, as ſome may think, I have employed more arguments than I needed, ſo others ſhould think I have omitted many, as indeed I have omitted ſome, that I might pertinently have employed.

BUT there is another ſort of perſons beſides thoſe I mentioned at the beginning of this preface, to whom I muſt addreſs the remaining part of it; namely, to thoſe who ſeem troubled, that I ſuffer my ſelf to be diverted either by *Linus* or Mr. *Hobbs* from perfecting thoſe experimental treatiſes that are lying by me, almoſt promiſed by the learned publiſher of the Latin edition of my eſſays; and from proſecuting thoſe ways of inquiry into the nature of things, wherein they are pleaſed to think I may be more ſerviceable to real learning and the lovers of it. And I confeſs that theſe men's reaſons and perſuaſions have ſo far prevailed with me, that after what I have done in the two following treatiſes, to vindicate my writings from the objections made againſt them by two learned men of very differing hypotheſes, and thereby to ſhew in ſome meaſure, that I am not altogether unacquainted with the way of defending oppoſed truths, I have laid aſide the thoughts of writing any more diſtinct or entire polemical treatiſes about the ſubjects already diſputed of. And to this I am invited by ſeveral other reaſons, (beſides what I have newly intimated.)

About the hiſtory of flame, of heat, of colours, of the origin of qualities and forms, &c.

FOR firſt, as I elſewhere declare, it was not my chief deſign to eſtabliſh theories and principles, but to deviſe experiments, and to enrich the hiſtory of nature with obſervations faithfully made and delivered; that by theſe and the like contributions made by others, men may in time be furniſhed with a ſufficient ſtock of experiments, to ground hypotheſes and theories on. And though, in my *Phyſico-Mechanical Epiſtle* and my *Specimens* I have ventured ſome conjectures alſo as the cauſes of the phænomena I relate, leſt the diſcourſe ſhould appear to inquiſitive readers too jejune; yet (as I formerly ſaid) I propoſed my thoughts but as conjectures deſigned (though not only, yet chiefly) to excite the curioſity of the ingenious, and afford ſome hints and aſſiſtance to the diſquiſitions of the ſpeculative. And accordingly I have not forborn to mention divers things, which judicious readers may eaſily perceive I foreſaw, that many would think unfavourable to the opinions I inclined to. So that for me to leave experimental for controverſial ſtudies, were a courſe unſuitable to the principal ſcope of my writings.

NEXT, though I have adventured to improve the doctrine of the ſpring and weight of the air, by ſome ſupplements where I found it deficient, and to recommend it by ſome new illuſtrations and arguments deduced from my experiments; yet the hypotheſes themſelves (for the main) being the opinions alſo of far learneder men than I, it might be thought injurious both to them and to our common cauſe, if I ſhould needleſly go about to hinder them from the honour of vindicating the truths we agree in; eſpecially ſome of them being excellent Mathematicians, and others eminent Naturaliſts, whoſe concern to maintain the hypotheſes againſt objections, if any ſhall ariſe, is equal to mine, and whoſe leiſure and abilities far exceed thoſe of a perſon who both is ſickly, and hath other employments enough, and who (if he were far better ſkilled in geometry than he pretends to be) hath ſuch a weakneſs in his eyes, as makes him both unwilling and unfit to engage in any ſtudy where the converſing with mathematical ſchemes is neceſſary.

THIRDLY, nor do I ſee much cauſe to doubt that the things I have delivered will, notwithſtanding my ſilence, be left undefended: the forwardneſs I have already obſerved in divers Virtuoſi to vindicate thoſe writings, which they are pleaſed to ſay have convinced them, and to ſave me the labour of penning the following treatiſes, ſcarce permitting me ſuch an apprehenſion; eſpecially ſince there are ſome things that will much facilitate their taſk, if not keep men from putting them upon it. For though Mr. *Hobbs* and *Linus* have examined my writings upon principles wherein they differ as much from each other as from me; yet neither have they ſeen cauſe to deny any thing that I deliver as experiment, nor have their objections been conſiderable, whether as to number or to weight, againſt the applications I have made of my principles to ſolve the phænomena. So that uſually, without objecting any incongruity to my particular explications, they are fain to fall upon the hypotheſes themſelves: in whoſe defence I think I may with the more reaſon expect to be ſeconded, becauſe not only I have endeavoured, as I formerly noted, to lay the grounds of anſwering ſuch objections as I foreſaw might ariſe; but I have alſo, to prevent or eaſe their labour, written the two firſt parts of my defence againſt *Linus*, without being obliged to do ſo for the vindicating of my explications, which are particularly maintained in the third part.

I KNOW not whether I may venture to add on this occaſion, that thoſe who have taken notice of the uſefulneſs of experiments to true philoſophy, and have obſerved that nevertheleſs the difficulty, trouble and charge of making them is ſuch, that even in this learned age of ours, there are very few *Bacons* or *Merſennus's* to be met with, and thoſe who have either made themſelves, or at leaſt ſeen others make

experiments,

experiments, even ſuch as thoſe I have publiſhed, with the care I am wont to think my ſelf obliged to employ on ſuch occaſions, will perhaps not only believe that they coſt me far more time and pains than they that have not made nor ſeen ſuch trials, are apt to imagine; but will poſſibly think it enough for a perſon, that is not by profeſſion a ſcholar, to make them carefully and ſet them down faithfully, and will allow him to let others vindicate the truths he may have the good fortune to diſcover; eſpecially, when there are ſo many fitter for it than he, who have (as well as his adverſaries) more leiſure to write diſputations than opportunity to proſecute experiments; the latter of which, to be performed as it ought to be, doth, in many caſes, beſides ſome dexterity ſcarce to be gained but by practice, require ſometimes more diligence, and oftentimes too more coſt than moſt are willing, or than many are able to beſtow upon them.

To be ſhort; though if any thing very worthy to be taken notice of by me be ſuggeſted againſt any of my chief opinions or explications, I may either take occaſion to ſay ſomewhat to it elſewhere, or at leaſt have an opportunity to conſider it in a review, wherein I may alter, mend, ſupply, vindicate or retract divers paſſages of my other writings: yet I would not have it expected that I ſhould exchange a book with every one that is at leiſure to write one againſt a vacuum, or about the air. Which declaration I make, not that I think it will, or ought to hinder any man from making uſe of his liberty to expreſs a diſſent, if he ſees cauſe; but for theſe two reaſons.

The one, that my ſilence might not injure either the truth or my ſelf, by tempting men to think, that whatever I do not anſwer, I cannot; but might give unbiaſſed and judicious readers a caution to allow as little of advantage to the writings of my adverſaries upon the account of their being unanſwered by me, as if I were no longer in the world. And the other, that I may not hinder thoſe who would reply to ſuch adverſaries by leaving them an apprehenſion that either I may prevent them, or they me. To conclude, I ſee no cauſe to deſpair, that whether or no my writings be protected, the truths they hold forth will, in time, in ſpite of oppoſition, eſtabliſh themſelves in the minds of men, as the circulation of the blood, and other, formerly, much conteſted truths, have already done. My humour has naturally made me too careful not to offend thoſe I diſſent from, to make it neceſſary for any man to be my adverſary upon the account of perſonal injuries or provocations. And as for any whom either judgment or envy may invite to contend, that the things I have communicated to the world deſerved not ſo much applauſe as they have had the luck to be entertained with; that ſhall make no quarrel betwixt us: for perhaps I am my ſelf as much of that mind as he; and however I ſhall not ſcruple to profeſs my ſelf one of thoſe who is more deſirous to ſpend his time uſefully, than to have the glory of leaving nothing that was ever written againſt him unanſwered; and who is more ſolicitous to purſue the ways of diſcovering truth, than to have it thought that he never was ſo much ſubject to human frailties as to miſs it.

A Defence of Mr. ROBERT BOYLE's Explications of his *Phyſico-Mechanical Experiments*,

AGAINST

FRANCISCUS LINUS.

PART I.

Wherein the Adverſary's Objections againſt the Elateriſts are examined.

CHAP. I.

A NEWLY-publiſhed treatiſe, *De Corporum inſeparabilitate*, being brought to my hands, I find ſeveral chapters of it employed to oppoſe the explications I ventured to give of ſome of my new experiments, touching the ſpring of the air. Wherefore, though I am very little delighted to be engaged in controverſies, and though I be not at preſent without employments enough (of a private, and of a publick nature) to make it unſeaſonable for me, to be by a work of this ſort diverted from them; yet for the reaſons ſpecified in the preface, I hold it not amiſs to examine briefly what is objected againſt the thing I have delivered: and the rather, partly, becauſe the learned author, whoever he be (for it is the title-page of his book that firſt acquainted me with the name of *Franciſcus Linus*) having forborn provoking language in his objections, allows me in anſwering them to comply with my inclinations and cuſtom of exerciſing civility, even where I moſt diſſent in point of judgment. Beſides, the author himſelf has ſomewhat facilitated my reply to him, by directing me in the ninth page to ſome books and paſſages that I had not, when I publiſhed my epiſtle, either ſeen or taken notice of. As indeed there are beſides ſome of theſe ſeveral other diſcourſes that treat of the Torricellian experiments, which, though by the names of their authors I gueſs to

be learnedly written, I have not to this day had opportunity to peruſe; my ſtay in the remoter part of *Ireland* (whither philoſophical books were not, in that time of publick confuſion, brought) having kept me from hearing of divers of them, till they were all bought up. Which I here mention, to excuſe my ſelf if I have not taken notice of ſome things or paſſages to be met with in theſe writings, which their learned authors or inquiſitive readers might juſtly perhaps expect I ſhould take ſome notice of, in caſe thoſe writings had fallen into my hands. But to digreſs no further.

It is true indeed, and it ſomewhat troubles me that it is ſo, that I can ſcarce promiſe my ſelf to make my adverſary a proſelyte, ſince he without ſcruple aſſumes thoſe very things as principles, that to me ſeem almoſt as great inconveniencies as I would deſire to ſhew any opinion I diſlike, to be liable unto. But ſince whatever operation the following diſcourſe may have upon the perſon that occaſioned it, I hope it may bring ſome ſatisfaction to thoſe philoſophers who can as little as I underſtand the Ariſtotelian rarefaction, and who will as well as I be backward to admit what they cannot underſtand; it ſhall ſuffice me to defend the truths I have delivered, if I cannot be ſo happy as to convince my acute adverſary of them; and I ſhall not believe my labour loſt, if this diſcourſe can contribute to the eſtabliſhment of ſome notions in philoſophy that I think not inconſiderable in the minds of thoſe whoſe clear principles make me the moſt reſpect their judgments, and for whoſe ſakes I principally write.

Now though I be not in ſtrictneſs obliged to defend any more than ſuch of my own explications as the examiner has thought fit to queſtion, and thoſe particulars which I have added by way of improvement to the two hypotheſes of the ſpring and weight of the air; yet that I may the more effectually proſecute what I lately intimated I aim at in this writing, and may as well illuſtrate my doctrine as defend it, I ſhall divide the enſuing treatiſe into three parts; whereof the firſt is deſigned to anſwer my adverſary's objections againſt our principles; the ſecond ſhall examine the funicular hypotheſis he would ſubſtitute in their ſtead; and the third ſhall contain particular replies to what he alledges againſt ſome of my particular explications.

CHAP. II.

Although our author confeſſes in his ſecond chapter, that the air has a ſpring as well as a weight, yet he reſolutely denies that ſpring to be near great enough to perform thoſe things which his adverſaries (whom for brevity ſake we will venture to call Elateriſts) aſcribe to it. And his whole fourth chapter, as the title declares, is employed to prove that the ſpring of the air is unable in a cloſe place to keep the mercury ſuſpended in the Torricellian experiment. The proof of this aſſertion he ſays is eaſy: but alledges two or three arguments for it, which I think will be more eaſily anſwered than his aſſertion evinced.

In the firſt he ſays, that thoſe experiments concerning the adheſion of one's finger, *&c.* which he had mentioned in the foregoing chapter, *eodem modo ſe habent in loco clauſo ac in aperto.* But the anſwering of this we ſhall ſuſpend till anon; partly, becauſe it may then be more conveniently examined and; partly, becauſe our author ſeems not to build much upon it, his chief argument being that which he propoſes in theſe words: *Cum tota vis hujus* Page 20. *Elaterii pendeat à refutato jam aëris æquipondio cum digitis* $29\frac{1}{2}$ *argenti vivi, ita ut nec plus, nec minus faciat hoc elaterium in loco occluſo, quam ſit per illud æquipondium in loco aperto; manifeſtum eſt, cum jam oſtenſum ſit fictitium planè eſſe hujuſmodi æquipondium, fictitium quoque eſſe tale elaterium.* 'Being the whole power 'of the ſpring of the air depends upon the 'æquilibrium of its weight with twenty nine 'inches and a half of quickſilver, ſo that this 'ſpring doth neither more nor leſs in a ſhut 'place, than is done by that æquilibrium in 'an open place; it is manifeſt, ſeeing we have 'ſhewed the æquilibrium to be plainly fictitious and imaginary, that the ſpring aſcribed 'to the air is ſo likewiſe.' Wherefore ſince all the validity of his objection againſt the ſpring of the air depends upon his former chapter, wherein he thinks he has diſproved the weight of the air; it will behove us to look back into the former chapter, and examine the four arguments which he there propoſes. But I muſt crave leave to vary from his method, and conſider the third in the firſt place, becauſe the removal of that objection will facilitate and ſhorten the anſwer to the reſt. His third argument therefore is thus ſet down: *Nam ſi* Page 16. *tubus viginti tantum digitorum (quo uſi ſumus in primo argumento) non totus impleatur argento, ut prius, ſed ſpacium aliquod inter digitum ſuperiorem & argentum relinquatur in quo ſit ſolus aër; videbimus ſubtracto inferiore digito ſuperiorem non ſolum deorſum trahi, ut prius, ſed etiam argentum jam deſcendere, idque notabiliter, quantum nimirum extendi poteſt exigua illa aëris particula à tali pondere deſcendente. Unde ſi loco illius aëris ponatur aqua, aliuſve liquor qui non tam facilè extenditur, deſcenſus nullus erit.*

Hinc, inquam, contra hanc ſententiam formatur argumentum: nam ſi externus ille aër nequeat vel hos viginti digitos argenti à lapſu ſuſtentare, uti jam vidimus, quomodo quæſo ſuſtentabit $29\frac{1}{2}$*? Certè hæc nullatenus reconciliari poſſunt.*

'For if a tube but twenty inches long (ſuch 'as we uſed in our firſt argument) be not 'quite filled with quickſilver, as before, but 'a little ſpace be left betwixt the mercury and 'the finger on the top of the tube, in which air 'only may abide; we ſhall find that the finger 'below being removed, the finger on the top 'will not only be drawn downwards, as be'fore, but the quickſilver ſhall deſcend alſo, 'and that notably, *viz.* as much as ſo ſmall a 'parcel of air can be extended by ſuch a deſcend'ing weight. So that if, inſtead of air, water, 'or any other liquor which is not ſo eaſily ex'tended, be put in its place, there will be no 'deſcent at all.'

'Hence, I ſay, againſt this opinion an ar'gument

'gument is framed: for if the external air can-
'not keep up thoſe twenty inches of quickſil-
'ver from deſcending, as we have proved; how
'ſhall it keep up twenty nine inches and an
'half? Aſſuredly theſe can no way be reconciled.'

BUT to this argument, which he thinks ſo irreconcilable with his adverſary's hypotheſis, he has himſelf furniſhed them with an anſwer in theſe words; *Dices forte ideo argentum in hoc caſu deſcendere, quia deorſum truditur ab aëre illo ſeſe per ſuum Elaterium dilatante.* 'You 'will perchance ſay, that the quickſilver there-'fore doth in the alledged caſe deſcend, becauſe 'it is thruſt down by that parcel of air which 'dilates itſelf by its own ſpring.' Which anſwer I think ſufficient for the objection, notwithſtanding the two exceptions he takes at it.

FOR firſt, whereas he ſays, that *ſic deberet digitus potius à tubo repelli, quam eidem affigi, cum non minus ſurſum quam deorſum fiat hujuſmodi dilatatio:* 'So ſhould the finger be rather 'thruſt from the top of the tube, than thereby 'faſtened to it; becauſe this dilatation muſt 'be made as well upwards as downwards:' He conſiders not, that though the endeavour of the included air to expand itſelf be at firſt every way alike, yet the expanſion itſelf in our caſe muſt neceſſarily be made downward, and not upward; becauſe the finger that ſtops the tube being expoſed on the upper parts and the ſides to the external air, has the whole weight and preſſure of the atmoſphere upon it; and conſequently cannot be thruſt away but by a force capable to ſurmount that preſſure: whereas on the lower ſide of the included air there is the weight of the whole mercurial cylinder to aſſiſt the ſpring of the air to ſurmount the weight of the atmoſphere, that gravitates upon the reſtagnant mercury. So that the air included and endeavouring to expand itſelf, finding no aſſiſtance to expand itſelf upward, and a conſiderable one to expand itſelf downward, it is very natural that it ſhould expand itſelf that way whence it finds leſs reſiſtance. As accordingly it will happen, till the ſpring of the air be ſo far dilated by its expanſion, that its preſſure, together with the weight of the mercury that remains ſuſpended, will but counter-balance, not overcome, the preſſure of the outward air upon the reſtagnant mercury. And this explication may be confirmed by this trial that I have purpoſely made; namely, that if inſtead of quickſilver you employ water, and leave as before in the tube an inch of air, and then inverting it, open it under water, you will perceive the included inch of air not to dilate itſelf any thing near (for I need not here define the proportion) half ſo far as it did when the tube was almoſt filled with mercury; becauſe the weight of ſo ſhort a cylinder of water does but equal that of between an inch and an inch and an half only of quickſilver; and conſequently the inward air is far leſs aſſiſted to dilate itſelf, and ſurmount the preſſure of the outward air by the cylinder of water, than by that of mercury. And as for what our author ſays, that if inſtead of air, water or ſome other liquor be left at the top of the tube, the quickſilver will not deſcend; the Elateriſts can readily ſolve that phænomenon, by ſaying that water has either no ſpring at all, or but an exceeding weak one; and ſo ſcarce preſſes but by its weight, which in ſo ſhort a cylinder is inconſiderable. Now the ſame ſolution we have given of our examiner's objection, gives us alſo an account why the finger is ſo ſtrongly faſtened to the upper part of the tube it ſtops; for the included air being ſo far dilated, that an inch, for example, left at firſt in the upper part of the tube, reaches twice or thrice as far as it did before the deſcent of the quickſilver, its ſpring muſt be proportionably weakened. And conſequently that part of the finger that is within the tube will have much leſs preſſure againſt it from the dilated air within, than the upper part of the ſame finger will have from the unrarefied air without. By which means the pulp of the finger will be thruſt in (which our author is pleaſed to call ſuck'd in) as we ſhall ere long have occaſion to declare in our anſwer to his ſecond argument.

AND having ſaid thus much to our author's firſt exception againſt the ſolution he foreſaw we would give of his third argument; we have not much to ſay at preſent to this ſecond. For whereas he ſays, *Concipi non poſſe quomodo aër* Page 17. *ille ſic ſe dilatet, argentumque deorſum trudat, niſi occupando majorem locum: quod tamen hi authores quam maxime refugiunt, aſſerentes rarefactionem not aliter fieri, quam per corpuſcula aut vacuitates.* 'It cannot be conceived how 'that air ſhould dilate itſelf, or thruſt down 'the mercury, unleſs by taking up a greater 'place; which thing theſe authors are much 'againſt, aſſerting that rarefaction can be made 'no other ways than by corpuſcles or vacuities.' I wiſh he had more clearly expreſſed himſelf, ſince as his words are couched I cannot gueſs what he means, and much leſs eaſily diſcern how they make an argument againſt his adverſaries. For, ſure he thinks them not ſo abſurd, as to imagine that the air can dilate itſelf, and thruſt down the mercury, without in ſome ſenſe taking up more room than it did before: for the very word dilatation, and the effect they aſcribe to the included air, clearly imply as much; ſo that I ſee not why he ſhould ſay that they are ſo averſe from granting the air to take up more place than before, eſpecially ſince he takes notice in the former chapter, that we compare the expanſion of the air to that of compreſſed wool; and ſince he here alſo annexes, that we explicate rarefaction either by corpuſcles or vacuities. But this latter clauſe makes me ſuſpect his meaning to be, that the Elateriſts do not admit that the ſame air may adequately fill more of place at one time than at another; which I believe to be as true as that the ſelf-ſame lock of compreſſed wool has no more hairs in it, nor does adequately fill more place with them, when it is permitted to expand itſelf, than whilſt it remained compreſſed. But againſt this way of rarefaction our author here has not any objection, unleſs it be intimated in theſe words, *Concipi non poteſt:* which if it be, I ſhall need only to mind him in this place, that whereas many of the chiefeſt philoſophers, both of ancient and our own times, have profeſſed they thought not the Ariſtotelian way of

rarefaction conceivable; and he acknowledges (as we shall see anon) that it is not clear; what the ablest of his party (the modern Plenists) are wont to object against the way of rarefaction he dislikes, is, that it is not true, not that it is not intelligible.

CHAP. III.

OUR author's second objection (for so I reckon it) is thus proposed by him: *Si* Page 15. *sumatur tubus utrinque aperius sed longior, puta digitorum 40. argentoque impleatur, eique digitus supernè applicatur ut prius, videbimus subtracto inferiore digito, argentum quidem descendere usque ad consuetam suam stationem; digitum autem superiorem fortiter intra tubum trahi, eique firmissime, ut prius, adhærere. Ex quo rursum evidenter concluditur, argentum, in sua statione constitutum, non ibidem sustentari ab externo aëre, sed à funiculo quodam interno suspendi, cujus superior extremitas, digito affixa, eum sic intra tubum trahit, eique affigit.* 'If you 'take a tube open at both ends of a good 'length, suppose forty inches long, and fill it 'with mercury, and place your finger on the 'top as before, taking away your lower finger, 'you will find the mercury to descend even to 'its wonted station, and your finger on the 'top to be strongly drawn within the tube, and 'to stick close unto it. Whence again it is 'evidently concluded that the mercury placed 'in its own station is not there upheld by the 'external air, but suspended by a certain inter-'nal cord, whose upper end being fastened to 'the finger, draws and fastens it after this man-'ner into the tube.' But this argument being much of the same nature with that drawn from his third experiment, the answer made to that and to his first may be easily applied, and will be sufficient for this also; especially because in our present case there is less pressure against the pulp of the finger in the inside of the tube than in the third experiment, (where some air is included, though much expanded and weakened;) the pressure of the atmosphere being in the present case kept off from it by the subjacent mercury: whereas there is nothing of that pressure abated against the other parts of the finger that kept it off from the deserted cavity of the tube, save only that from the pulp that is contiguous to the tube, there may be somewhat of that pressure taken off by the weight of the glass itself. But as for that part of the finger which immediately covers the hole, whether or no there be any spring in its own fibres, or other constituent substances, which finding no resistance in the place deserted by the quicksilver, may contribute to its swelling (for that we will not now examine) he that has duly considered the account already given of this intrusion of the pulp into the glass, will find no need of our author's internal funiculus; which to some seems more difficult to conceive, than any of the phænomena in controversy is to be explained without it.

CHAP. IV.

BY what we have already said against our examiner's third argument, we may be assisted to answer his first, though he propose it as a very clear demonstration; and though it be indeed the principal thing in his book. *Sumatur* (says he) *tubus brevior digitis* $29\frac{1}{2}$ Page 12. *puta digitorum 20. non tamen clausus altero extremo, (ut hactenus) sed utrinque apertus: hic tubus, immerso ejus orificio argento restagnanti, suppositoque digito, ne effluat argentum tubo infundendum, impleatur argento vivo: aliusque deinde digitus orificio quoque applicetur, illudque bene claudat. Quo facto, si subtrahatur inferior digitus, sentietur superior vehementer trahi ac fugi intra tubum, tamque pertinaciter ei (vel argento potius, ut postea) adhærere, ut ipsum tubum cum toto argento incluso facilè elevet teneatque in vase pendulum.*

Ex quo sane experimento clarissimè refellitur hæc sententia: cum enim, juxta eam, argentum in tubo hujusmodi 20 tantum digitorum, sursum trudatur à præponderante aëre externo: nunquam profecto per eam explicabitur, quomodo digitus ille sic trahatur deorsum, tuboque tam vehementer adhæreat; non enim à trudente sursum potest sic deorsum trahi.

'Take a tube shorter than twenty nine 'inches and an half, for instance of twenty 'digits, not shut, as hitherto, at one end, but 'with both ends open: let this tube, its orifice 'being immersed in restagnant mercury, and 'one finger being placed underneath, that the 'mercury to be poured in run not through, 'be filled with mercury; and then another 'finger be applied to its orifice, to close it well: 'which being done, if you draw away your 'lower finger, the upper will be found to be 'strongly drawn and sucked into the tube, 'and so stiffly to adhere to it, (or rather to the 'quicksilver, as I shall hereafter shew) that it 'will elevate the tube itself with all the quick-'silver, and make it continue to hang pendu-'lous in the vessel.

'From which experiment this opinion is 'most clearly refuted: for seeing according to 'it the quicksilver in such a tube but twenty 'inches long must be thrust upwards by the 'preponderating air; it will never by it be ex-'plained how this finger is so drawn down-'wards, and made so strongly to stick to the 'tube. For it cannot by the air thrusting 'upwards be thus drawn downwards.'

Thus far our author's objection, in answer whereunto I have divers things to represent, to shew, that a good account may be given of this experiment in the hypothesis of the Elaterists; which is sufficient to manifest how far the argument is from being so unanswerable as the proposer of it would persuade his reader.

I Deny then that the finger is drawn downward, or made by suction to adhere to the tube; but I explicate that which he calls the suction of the finger, as I lately did in answer to his third argument, as we shall more particularly seen anon.

He says indeed, that the air which thrust up the quicksilver cannot so strongly draw down the finger. As if the air were not a fluid body, but a single and intire pillar of some solid matter. But to shorten our reply to his objections, the best way perhaps will be briefly to explicate the phænomenon thus:

When

WHEN the tube is filled with quickſilver, the finger that ſtops the upper orifice is almoſt equally preſſed above and at the ſides by the contiguous air; but when the lower finger is removed, then the cylinder of mercury, which before gravitated upon the finger, comes to gravitate upon the reſtagnant mercury, and by its intervention to preſs againſt the outward air: ſo that againſt thoſe parts of the finger that are contiguous to the air there is all the wonted preſſure of the outward air; whereas againſt that pulp that is contiguous to the mercury there is not ſo much preſſure as againſt the other parts of the finger, by two thirds. I ſay by two thirds, or thereabout, becauſe the mercurial cylinder in this experiment is ſuppoſed to be twenty inches high; and if it were but a little more than thirty inches high, (which is a third more) then the weight of the quickſilver would take off not two thirds only, but the whole preſſure of the outward air, from the above-mentioned pulp of the finger. For in that caſe the quickſilver would quite deſert it, and ſettle beneath it. Wherefore ſince it has appeared by our anſwer to the examiner's third argument, that the preſſure of the outward air is taken off from the body that remains in the upper part of the tube, according to the weight of the liquor ſuſpended in the tube; and ſince in our hypotheſis the preſſure of the outward air is able to keep thirty inches of quickſilver, or two or three and thirty foot of water, ſuſpended in a tube; it need be no great wonder, if a preſſure of the ambient air, equal to the weight of a cylinder of water of near twenty two foot long, ſhould be able to thruſt in the pulp of the finger at the upper orifice of the tube, and make it ſtick cloſely enough to the lip of it.

I KNOW the examiner affirms, that no thruſting or preſſure from without can ever effect ſuch an adheſion of the finger to the tube. But this ſhould be as well proved as ſaid. But, firſt, though I am willing to think the examiner would not knowingly relate any thing he is not perſuaded of; yet as far as I, and another perſon very well verſed in theſe experiments, have purpoſely tried, I could not find the adheſion of the finger to the tube to be near ſo ſtrong as our author hath related. Secondly, if you carefully endeavour by preſſure and otherwiſe to thruſt the pulp of your finger into the orifice of the tube, you may through the glaſs perceive it to be manifeſtly tumid in the cavity of the pipe. And if by preſſing your finger againſt the orifice of the tube, you ſhould not make the pulp adhere quite ſo ſtrongly to the tube, nor ſwell quite ſo much within it, as may happen in ſome mercurial experiments; it is to be conſidered, that the air being a fluid as well as a heavy body, it does not (as groſſer weights would) preſs only againſt the upper part of the finger, but preſſing as much of the finger as is expoſed to it almoſt every where, and almoſt uniformly, as well as ſtrongly, it does by its lateral preſſure on every ſide thruſt in the pulp of the finger into the hole, where there is not any reſiſtance at all, or at leaſt near ſo much preſſure againſt the pulp as that of the ambient air againſt the parts of the finger contiguous to it.

BY this it may appear that we need not borrow the objection our author offers to lend us; namely, that in the experiment under conſideration the quickſilver is preſſed downward by the ſpring of ſome air lurking betwixt it and the finger. (Though I am prone to think that unleſs the experiment be made with a great deal of care, ſuch a thing may eaſily happen, and contribute to the ſtronger adheſion of the finger to the tube.) This I ſay may appear, notwithſtanding what our author objects, that the air expanding it ſelf will thruſt away the finger upwards, ſince the contrary of that pretence we have lately manifeſted in the anſwer to his third argument. And as for what he adds, to confirm his argumentation, in theſe words; *Quod vel inde confirmatur, quia cum præponderans ille aër* Page 14. *ſuccedat (uti aſſeritur) loco ſublati inferioris digiti, id eſt, eodem modo nunc ſuſtentet argentium quo ante ab applicato digito inferiore ſuſtentabatur; manifeſtum eſt, non debere, juxta hanc ſententiam, magis deorſum trahi digitum ſuperiorem poſt ſublatam inferiorem quam ante. Cum itaque contrarium planè doceat experientia, ſatis liquet ſententiam illam eſſe falſam:* 'Which is thence 'confirmed, becauſe if that preponderating 'air ſucceeds, as is aſſerted, in the place of 'the lower finger which was withdrawn, that 'is, if it uphold the quickſilver after the ſame 'manner which it was upheld by the lower 'finger applied under it; it is manifeſt, ac-'cording to this opinion, that the finger on 'the top ought not to be more drawn down-'wards after the lower finger is removed than 'before. Seeing then that experience teacheth 'the contrary, it is manifeſt that opinion muſt 'be falſe:' We muſt conſider that the tube being ſuppoſed perfectly full of mercury, the finger that ſtops the lower orifice, is wont to be kept ſtrongly preſſed againſt it, leſt any of that ponderous liquor ſhould get out between the tube and the finger. So that although both the lower finger do indeed keep up the mercury in the tube, and the preſſure of the outward air would do ſo too; yet there is this difference, that the preſſure of the atmoſphere depending upon its weight, cannot be intended and weakened as we pleaſe, as can that of the undermoſt finger. And therefore whereas the atmoſpherical cylinder will not keep up a cylinder of quickſilver of above thirty inches high, thoſe that make the Torricellian experiment do often, upon one occaſion or other, keep up with the finger a mercurial cylinder of perhaps forty or fifty inches, or far more: ſo that whereas in our caſe, before the removal of the undermoſt finger, the pulp of the uppermoſt muſt have about the ſame preſſure againſt it where it is contiguous to the mercury, as there is againſt the other part of the ſame finger; after the removal of the undermoſt finger, there is as much of the atmoſpherical preſſure, if I may ſo ſpeak, taken off from the newly mentioned pulp, as counter-balances a cylinder of quickſilver of twenty inches long.

CHAP.

CHAP. V.

Page 18. THE examiner's fourth and laſt experiment is thus propoſed: *Quarto denique* (ſays he) *impugnatur; quia ex eo ſequetur, argentum vivum per ſimilem tubum è vaſculo exugi poſſe eâdem prorſus facilitate qua ex eodem exugeretur aqua: quod tamen experientiæ repugnat, quâ docemur aquam in os ſugentis facillimè attrahi; quo tamen argentum vivum ne toto quidem adhibito conatu perduci queat, imo vix ad tubi medietatem.*

Sequelam autem ſic oſtendo: Quia cum in hac ſententia nihil aliud agendum ſit quam hoc, ut per tubum ſic aſcendat ſubjectus liquor, ſive aqua fuerit, ſive argentum, niſi ut ſugendo ſurſum trahatur aër tubo incluſus, quo ſic attracto aſcendit illico ſubjectus liquor, protruſus nimirum ab externo aëre jam præponderante (*uti docet* Pecquetus *in diſſertatione anatomica pag.* 63.) *manifeſtum eſt, eadem planè facilitate exugendum ſic argentum vivum qua exugitur aqua: quod quum experientiæ tam aperte repugnat, neceſſe eſt ſententiam ex qua ſequitur falſam eſſe.*

'IN the fourth place, it is impugned, be-
'cauſe thence it would follow that quickſilver
'through a like tube might be ſucked with
'the ſame eaſineſs out of a veſſel that water is
'ſucked out of the ſame. Which notwith-
'ſtanding is contrary to experience, by which
'we are taught that water is eaſily drawn into
'the mouth of him that ſucks; whereas quick-
'ſilver cannot be drawn thither by his utmoſt
'endeavour, nay, ſcarce unto the middle of
'the tube.

'THE ſequel I thus manifeſt: Becauſe ſee-
'ing, according to this opinion, that the li-
'quor underneath, whether it be water or mer-
'cury, may ſo aſcend, no more is required
'but that the air ſhut in the tube may be
'drawn upwards by ſucking; which being
'drawn up, the liquor underneath will imme-
'diately aſcend, being thruſt thither by the
'external air now preponderating, (as *Pecquet*
'declares in his Anatomical Diſcourſe, *p.* 63.)
'it is manifeſt that the mercury may be ſuck-
'ed out with the ſame eaſineſs that water is
'ſucked out with. Which being ſo evidently
'againſt experience, the opinion from whence
'it is deduced muſt needs be falſe.'

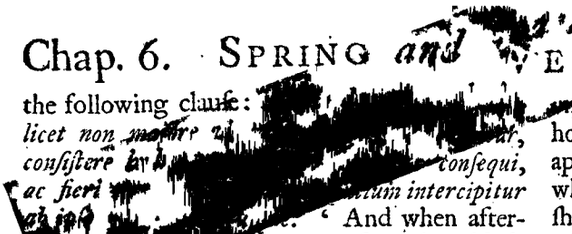
THIS experiment I remember I made ſome years ago, accordingly it is alledged in the fourth eſſay of the treatiſe (I was then writing) to prove againſt the vulgar opinion, that liquors do not, to prevent a vacuum, ſpontaneouſly aſcend; which I preſume will be ſo far allowed of by our author, who would have liquors ſuppoſed to be raiſed by ſuction violently drawn up by the contraction of his funiculus. But to examine this experiment, as it concerns the preſent controverſy, we may recall to mind that we formerly ſhewed in the anſwer to our author's third argument, that when the mercurial cylinder that leans upon the reſtagnant mercury has at the other end of it air, kept from any intercourſe with the atmoſphere, that included air has ſo much of the preſſure of the external air taken off from it, as counterpoiſes the mercurial cylinder. And the finger that is expoſed to the whole preſſure of the ambient air in ſome of its parts, and in others but to the much fainter preſſure of the included air, endures an unuſual preſſure from the preponderating power of the atmoſphere.

WE may conſider alſo, that there is againſt the thorax, and thoſe muſcles of the abdomen that are ſubſervient to reſpiration, the preſſure of the whole ambient air. Which preſſure notwithſtanding, the muſcles deſigned for the uſe of reſpiration are able, without any conſiderable reſiſtance to dilate the thorax at pleaſure; becauſe, as faſt as they open the cheſt, and by dilating it weaken the ſpring of that air which is then within the body, the external air by flowing in, for want of finding the uſual reſiſtance there, keeps that within the thorax in an æquilibrium of force with that without. Theſe things premiſed, it is not difficult in our hypotheſis to give an anſwer to our examiner's experiment. For we ſay when a cylinder of mercury is raiſed in the tube to any conſiderable height, the preſſure of the air in the thorax is leſſened by the whole weight of that mercurial cylinder; and conſequently the reſpiratory muſcles are thereby diſabled to dilate the cheſt as freely as they were wont, by reaſon of the prevalency of the undiminiſhed preſſure of the external air againſt the weakened preſſure of the internal. But if inſtead of mercury you ſubſtitute water, ſo ſhort a cylinder of that comparatively light liquor takes off ſo little of the preſſure of the included air, that it comes into the lungs with almoſt its uſual ſtrength, and conſequently with almoſt as much force as the outward air preſſes with againſt the thorax.

AND on this occaſion there occurs to my thoughts a noble experiment of the moſt ingenious Monſieur *Paſchal*, which clearly ſhews, that if we could free the upper part of ſuch a tube as we are now conſidering from the preſſure of all internal air, it would follow, as the examiner ſays it ſhould, that the quickſilver would by the preſſure of the outward air be impelled up into the tube as well as water, till it had attained a height great enough to make its weight not inferior, but equal to that of the atmoſphere. The experiment it ſelf being ſo pertinent and conſiderable, we ſhall annex it in the ſame words wherein it is related by his countryman and acquaintance, the learned and candid *Gaſſendus: Neque hoc verò ſolum, ſed inſuper vitreo diabete clyſtereve ea qua par fuerit longitudine confecto, & poſt embolum ad orificium uſque compulſum, immiſſo ad normam in ſubjectum hydrargyrum, deprehendit, ubi embolum ſenſim deinde educitur, conſequi hydrargyrum aſcendereque ad eandem uſque duorum pedum & digitorum trium cum ſemiſſe altitudinem.* 'And not only
'this, but over and above, if a glaſs diabetes
'or ſyringe be made of a ſufficient length, and
'after that the ſucker is thruſt into the utmoſt
'orifice, it be placed according to uſe in the
'mercury underneath; he finds that as ſoon
'as the ſucker is drawn out, the mercury fol-
'lows, and aſcends to the ſame height of two
'feet and three inches and an half.' To which he immediately ſubjoins a circumſtance very conſiderable to the preſent controverſy, in

Gaſſ. Phyſ. Sect. 1. lib. 2. p. 204. De nupero Inanis experimento.

the

the following clauſe:  ' And when after- no greater force be added, ' is drawn higher, he finds that the ' mercury ſtands, and follows no further; and ' ſo that ſpace is made empty which remains ' between the mercury and the ſucker.' Thus far he. So that as to the examiner's experiment, we may well explicate it in our hypotheſis, by ſaying, that, agreeably to it, it happens, that in a more forcible reſpiration the mercurial cylinder is raiſed higher than in a more languid; becauſe, in the former caſe, the cheſt being more dilated, the included air is alſo more expanded; whereby its debilitated ſpring cannot as before enable the mercurial cylinder to counterpoiſe altogether the preſſure of the ambient air. And that the reaſon why the quickſilver is not by reſpiration raiſed as high as it is kept ſuſpended in the Torricellian experiment, is not, that the preſſure of the outward air is unable to raiſe it ſo high, but becauſe, as we have already declared, the free dilatation of the thorax is oppoſed by the preſſure of the ambient air: which preſſure being againſt ſo great a ſuperficies, and being but imperfectly reſiſted by the debilitated preſſure of the air within the thorax, will be eaſily imagined to be very conſiderable, by him who conſiders that in our engine the preſſure of the external air againſt the ſucker of leſs than three inches diameter was, as we relate in the 33d experiment, able to thruſt up a weight of above a hundred pound. And here we may obſerve upon the by, in confirmation of our former doctrine, that when we ſtrongly ſuck up quickſilver in a glaſs-tube, though the elevation of the quickſilver be, according to our author, performed likewiſe by his Funiculus contracting it. ſelf every way, and though there be a communication betwixt the internal ſurface of the lungs, and the cavity of the tube; yet we feel not in our lungs any endeavour of the ſhrinking Funiculus to tear off that membrane they are lined with.

AND thus we have examined our author's four arguments, to prove that in the Torricellian experiment the quickſilver cannot be kept ſuſpended by the counterpoiſe of the external air: againſt which opinion he tells us indeed, that other arguments might be alledged, but
Pag. 19. as it is not probable that if he had thought them better than thoſe he has elected to inſiſt on, he would have omitted them, ſo it is not unlikely that anſwers might be as well found for them as for the others; eſpecially ſince that which he ſingles out for a ſpecimen is, that from his adverſaries hypotheſis it would follow, that the quickſilver would deſcend much more (I ſuppoſe it is a miſtake of the preſs, for much leſs) in cold weather than in hot, becauſe the air is then thicker and heavier, and therefore ought to impel up the quickſilver higher. For beſides that we ſhall in its due place queſtion the validity of our author's conſequence, it will be here ſufficient to reply, that the obſervation which he grounds it does not conſtantly hold, as his objection ſuppoſes: which may appear by that part of our 18th experiment whence the matter of fact is deſumed, as we ſhall have occaſion to take further notice of when we ſhall come to the defence of that experiment. So that what has been hitherto diſcourſed on both ſides being duly conſidered, the reader is left to judge what ground the examiner had for the Επιφώνημα wherewith he is pleaſed to conclude his third chapter; *Maneat* Pag. 19. *igitur tot argumentis comprobatum, quorum quodlibet ſe ſolo ſufficit, argentum (facto experimento in loco aperto) per externi aëris gravitatem à lapſu minime ſuſtentari.* ' Be it therefore ' confirmed by ſo many arguments, of which ' every one is ſufficient in it ſelf, that quick- ' ſilver (the experiment being made in an open ' place) is not upheld from falling by the ' weight of the external air.'

CHAP. VI.

HIS fourth chapter, wherein the title promiſes that he will prove, *argentum in loco occluſo non ſuſtentari à lapſu per ipſum aëris elaterium*, ' that quickſilver in a cloſe place is ' not upheld from falling by the elater or ' ſpring of the air;' is very ſhort, and does not require that we ſhould dwell long upon it. For the proof he brings of his aſſertion being this, *Cum tota vis hujus elaterii pendeat à refu-* Page 20. *tato jam aëris æquipondio cum digitis* 29 ½ *argenti vivi, ita ut nec plus nec minus faciat hoc elaterium in loco occluſo quam fit per illud æquipondium in loco aperto; manifeſtum eſt, cum jam oſtenſum ſit fictitium planè eſſe hujuſmodi æquipondium, fictitium quoque eſſe tale elaterium:* ' Seeing the whole power of this ſpring de- ' pends upon the already-confuted æquilibrium ' of the air with 29 inches and an half of quick- ' ſilver, ſo that this ſpring does neither more ' nor leſs in a cloſe place than is done by that ' æquilibrium in an open place; it is manifeſt, ' ſeeing this æquilibrium is already ſhewn to be ' plainly fictitious and imaginary, that the ' ſpring of the air is ſo likewiſe.' This being no new argument, but an inference from thoſe he had ſet down in the former chapter, by our anſwers to them it is become needleſs for us to make any diſtinct reply to this. We ſhall rather deſire the reader to take notice, that whereas our author ſays, that according to his adverſaries, *Nec plus nec minus faciat hoc elaterium in loco occluſo quam fit per illud æquipondium in loco aperto:* ' And that this ſpring ' doth neither more nor leſs in a cloſe place, ' than is done by that æquilibrium in an open ' place:' Whatever others may have written, we for our part allow of this opinion but in ſome caſes; for in others we have performed much more by the ſpring of the air, which we can within certain limits increaſe at pleaſure, than can be performed by the bare weight, which for aught we know remains always ſomewhat near the ſame. And of this advantage that the ſpring of the air may have in point of force above the weight of it, we have formerly given an inſtance in our 17th experiment, (where,

by compreſſing the air in the receiver, we impelled the mercurial cylinder higher than the ſtation at which the counterpoiſe of the air is wont to ſuſtain it) and ſhall hereafter have occaſion to give yet more conſiderable proofs. To the lately recited words our examiner ſubPage 21. joins theſe; *Adde, cum allata jam capite præcedente experimenta de adhæſione digiti, &c. eodem modo ſe habent in loco clauſo ac in aperto, neceſſarium eſſe facta ex eis argumenta contra æquipondium, eadem quoque contra elaterium vim habere.* 'Add, that ſeeing the experiments 'brought in the chapter above of the adheſion 'of the finger, &c. are alike in a cloſe and an 'open place; it is neceſſary and certain, that 'the ſame arguments made againſt the æquili'brium have force againſt the ſpring of the 'air.' But though he propoſe this as a new argument, yet ſince it is built but upon the adheſion of the finger, (of which we have already given an account in our hypotheſis) I ſee not how it requires any new and particular anſwer. And whereas he ſays, that the experiments he had mentioned concerning the adheſion of one's finger, &c. *eodem modo ſe habent in loco clauſo ac in aperto*; I could wiſh he had added what way he took to make the trials. For he gives no intimation that he did them any other ways than in ordinary rooms: and in ſuch there ſcarce ever wants a communication betwixt the inward and outward air, either at the chimney, or window, or door not exactly ſhut, or at ſome hole or crevice or other, by means of which the weight of the atmoſphere has its operation within the room.

To his ſecond argument our author adds not a third, unleſs we take that for an argument which he immediately annexes to his laſt recited words: *Et profectò* (ſays he) *ſi ſecum* Page 21. *expenderent hi authores, quanta ſit difficultas explicandi hujuſmodi aëris elaterium, niſi idem aër ſe ſolo occupet majorem locum (ut paulo ante) credo eos ſententiam facilè mutaturos.* 'And 'really if theſe authors would conſider how 'great a difficulty there is in explaining this 'ſpring of the air, unleſs the ſame air by itſelf 'alone may take up a greater place, I believe 'they would readily alter their opinion.' But this being ſaid *gratis*, does not exact an anſwer; and he muſt make it more intelligible than any man that I know of has yet done, how the ſame air can adequately fill more ſpace at one time than at another, before he perſuade me to change my opinion about the ſpring of the air: eſpecially ſince he himſelf allows that Page 11. the air has a ſpring, whereby it is able, when it has been violently compreſſed, to recover its due extenſion; the manner whereof if he will intelligibly explicate, his adverſaries will have no great difficulty to make out the ſpring of the air. But whether his hypotheſis, or ours, be the more intelligible, will be more properly conſidered in the ſecond part of our diſcourſe, to which we will therefore now proceed.

PART II.

Wherein the Adverſaries Funicular Hypotheſis *is examined.*

CHAP. I.

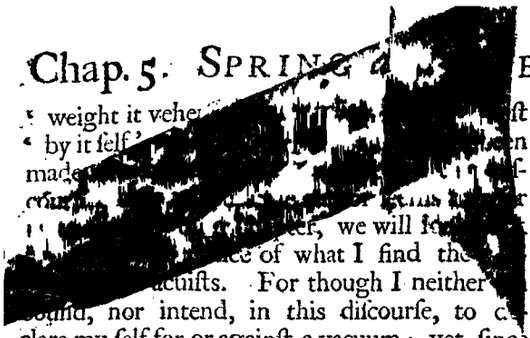
What is alledged to prove the Funiculus, *is conſidered; and ſome difficulties are propoſed againſt the hypotheſis.*

THE hypotheſis that the examiner would, as a better, ſubſtitute in the place of ours, is, if I miſtake it not, briefly this; That the things we aſcribe to the weight or ſpring of the air are really performed by neither, but by a certain Funiculus, or extremely thin ſubſtance, provided in ſuch caſes by nature, *ne detur vacuum*, which being exceedingly rarefied by a forcible diſtenſion, does perpetually and ſtrongly endeavour to contract it ſelf into dimenſions more agreeable to the nature of the diſtended body; and conſequently does violently attract all the bodies whereunto it is contiguous, if they be not too heavy to be removed by it.

BUT this hypotheſis of our author's does to me, I confeſs, appear liable to ſuch exceptions, that though I diſliked that of his adverſaries, yet I ſhould not embrace his, but rather wait till time and further ſpeculations or trials ſhould ſuggeſt ſome other theory, fitter to be acquieſced in than this; which ſeems to be partly precarious, partly unintelligible, and partly inſufficient, and beſides needleſs: though it will not be ſo convenient to prove each of theſe apart, becauſe divers of my objections tend to prove the doctrine, againſt which they are alledged obnoxious to more than one of the imputed imperfections.

FIRST, then, the arguments by which our author endeavours to evince his Funiculus, are incompetent for that end. The arguments which he propoſes in his ſixth chapter, (where he undertakes to make good his aſſertion) I there find to be three.

THE firſt he ſets down in theſe words; *Con-* Page 24. *ſtat hoc primò ex jam dictis capite præcedente: nequit enim argentum deſcendens ſic digitum deorſum trahere, tuboque affigere, niſi à tali funiculo ſuſpendatur, eumque ſuo pondere vehementer extendat, ut per ſe patet.* 'This appears from 'what has been already ſpoken in the pre'ceding chapter: for the quickſilver deſcend'ing, cannot ſo draw the finger downwards, 'and faſten it unto the tube, unleſs it be hung 'upon the finger by ſuch a cord, which by its weight



'weight it vehe… …ſt
'by it ſelf' …n
made … …f-
… …r
… …ef, we will ſe…
… …ce of what I find the…
… …cuiſts. For though I neither …
…ould, nor intend, in this diſcourſe, to c…
clare my ſelf for or againſt a vacuum; yet, ſince I am now writing againſt the funicular hypotheſis, it will much conduce to ſhew that it is not firmly grounded, if I examine what he here alledges againſt the aſſertors of a vacuum.

IN the next place therefore, I conſider that, according to the examiner, there can be no vacuum; and that he makes to be the main reaſon why nature in the Torricellian and our experiments does act after ſo extraordinary a manner as is requiſite to the production of his Funiculus. For, in the 47th page, having, in his adverſaries name, demanded what need there is, at the deſcent of the quickſilver, that before it falls a ſuperficies ſhould be ſeparated from it, and extended; *Reſpondeo*, (ſays he) *ideo hoc fieri, ne detur vacuum; cum nihil aliud ibi adſit quod loco argenti deſcendentis poſſit ſuccedere.* 'I anſwer, that 'this comes to paſs, that there may be no va'cuity, ſeeing there is nothing elſe there that 'can ſucceed into the place of the deſcending 'quickſilver.' To which he immediately ſubjoins, (with what cogency I will not now examine) *Atque hinc planè confirmatur commune illud per tot jam elapſa ſecula uſurpatum in ſcholis axioma, viz. Naturam à vacuo abhorrere.* 'And hence is confirmed that common 'axiom uſed in the ſchools for ſo many ages 'paſt, that nature doth abhor a vacuum.' And though he ſeem to make his Funiculus the immediate cauſe of the phænomena occurring in the Torricellian and our experiments; yet that, if you purſue the inquiry a little higher, he reſolves them into nature's abhorrency of a vacuum, himſelf plainly informs us in the next page; *Nam licet* (ſays he) *immediata ratio cur aqua v. g. ex hydria hortulana ſuperne clauſa (quo exemplo utuntur) non deſcendat, non ſit metus vacui, ſed ea quam modo diximus, nempe quod non detur ſufficiens pondus ad ſolvendum illum nexum quo adhæreat aqua clauſæ hydriæ ſummitati; ad eam tamen rationem tandem neceſſario veniendum eſt.* 'For though the im'mediate cauſe why water (for inſtance) doth 'not deſcend from a gardener's watering-pot, '(for that example they uſe) ſtopt on the top, 'is not the fear of a vacuum, but the reaſon 'now mentioned; namely, that there is not 'weight ſufficient to looſe that conjuncture 'by which the water doth adhere to the top 'of the cloſed water-pot: nevertheleſs, in the 'end, we muſt of neceſſity come to that 'cauſe.' But though, as well our author's Funiculus as the other ſcarce conceivable hypotheſes that learned men have deviſed, to account for the ſuſpenſion of the quickſilver otherwiſe than by the reſiſtance of the external air, ſeem to have been excogitated only to ſhun the neceſſity of admitting a vacuum; yet I ſee not how our examiner cogently proves, either that there can be none *in rerum naturâ*, or that *de facto* there is none produced in theſe experiments. For, in his fifth chapter (where he profeſſedly undertakes that taſk) he has but theſe two incompetent arguments. The firſt is drawn from the attraction, as he ſuppoſes, of the finger into the deſerted cavity of the tube in the Torricellian experiment: *Quæ quidem* (ſays he) *tam vehemens tractio & adhæſio, cum non niſi à reali aliquo corpore inter digitum & argentum conſtitutum queat provenire, manifeſtum eſt ſpatium illud vacuum non eſſe, ſed verâ aliquâ ſubſtantiâ repletum.* 'Which traction and ad'heſion, when it cannot proceed but from ſome 'real body placed between the finger and the 'mercury, it is manifeſt that that ſpace is not 'empty, but filled with ſome true ſubſtance.' But to this argument having already given an anſwer, let us (without ſtaying to urge, that the Vacuiſts will perhaps object, that they ſee not a neceſſity, though they ſhould admit of traction in the caſe, that the internal ſubſtance muſt therefore perfectly repleniſh the deſerted cavity; without preſſing this, I ſay, let us) conſider his other, which he draws from the diaphaneity of the deſerted part of the tube, which ſpace, he ſays, were it empty, would appear like a little black pillar, *Eo quod nullæ ſpecies viſuales neque ab eo neque per illud poſſunt ad oculum pervenire:* 'Becauſe no viſual ſpecies's could 'proceed either from it, or through it, unto 'the eye.' But (not to engage ourſelves in optical ſpeculations and controverſies) if we grant him ſomewhat more than perhaps he can prove; yet as the experiment will not demonſtrate that there is nothing of body in any part of the ſpace deſerted by the mercury, ſo neither will the argument conclude (as the propoſer of it does twice in this chapter) that ſpace *verâ aliquâ ſubſtantiâ repleri*, 'to be 'filled with any true ſubſtance.' For, according to the hypotheſis of the Epicureans and other Atomiſts, who make Light to be a corporeal effluvium from lucid bodies, and to conſiſt of atoms ſo minute as freely to get in at the narrow pores of glaſs, there will be no cauſe to deny interſperſed vacuities in the upper part of the tube. For the corpuſcles of light that permeate that ſpace may be ſo numerous, as to leave no ſenſible part of it un-inlightened; and yet may have ſo many little empty intervals betwixt them, that if all that is corporeal in the ſpace we ſpeak of were united into one lump, it would not perhaps adequately fill the one half (not to ſay the tenth, or even the hundredth part) of the whole ſpace: according to what we have noted in the 17th experiment, that a room may appear full of the ſmoke of a perfume, though if all the corpuſcles that compoſe that ſmoke were re-united, they would again make up but a ſmall paſtil. To which purpoſe I remember I have taken camphire, of which a little will fill a room with its odour, and having in well-cloſed diſtillatory glaſſes caught the fumes driven over by heat, I thereby reduced them to re-conjoin into true camphire, whoſe bulk is very inconſiderable in compariſon of the ſpace it fills as to ſenſe, when the odorous corpuſcles are ſcattered through the free air.

Page 48.
Page 22.

To

To which I might add, that the Torricellian experiment being made in a dark night, or in a room perfectly darkened, if it ſucceed (as there is little cauſe to expect it will not) it may well be doubted whether our author's argument will there take place. For if he endeavour to prove that the place in queſtion was full in the dark, becauſe, upon the letting in of the day, or the bringing in of a candle, the light appears within it, the Vacuiſts may reply according to their hypotheſis, that that light is a new one, flowing from the lucid body that darts its corporeal beams quite through the glaſs and ſpace we diſpute about, which, for want of ſuch corpuſcles, were not juſt before viſible.

And ſuppoſing light not to be made by a trajection of atoms through diaphanous bodies, but a propagation of the impulſe of lucid bobies through them; yet it will not thence neceſſarily follow, that the deſerted part of the tube muſt be full: as in our 27th experiment, (though many of thoſe groſs aërial particles that appeared neceſſary to convey a languid ſound were drawn out of our receiver at the firſt and ſecond exſuction; yet there remained ſo many of the like corpuſcles, that thoſe that were wanting, were not miſſed by the ſenſe, though afterwards, when a far greater number was drawn out, they were:) ſo there may be matter enough remaining to tranſmit the impulſe of light; though betwixt the particles of that matter there ſhould be ſtore of vacuities intercepted. Whereas our author pretends to prove, not only that there is no coacervate vacuity in the ſpace ſo often mentioned, but abſolutely that there is none. For it is in this laſt ſenſe as well as the other, that the ſchools, and our author who defends their opinion, deny a vacuum.

But notwithſtanding what we have now diſcourſed, as in our 17th experiment, we declined determining whether there be a vacuum or no; ſo now, what we have ſaid to the examiner's argument, has not been to declare our whole ſenſe of the controverſy, but only to ſhew, that though his hypotheſis ſuppoſes there is no vacuum, yet his arguments do not ſufficiently prove it; which may help to ſhew his doctrine to be precarious: for otherwiſe the Carteſians, though Pleniſts, may plauſibly enough (whether truly or no, I now diſpute not) decline the neceſſity of admitting a vacuum in the deſerted ſpace of the tube, by ſuppoſing it filled with their ſecond and firſt element, whoſe particles they imagine to be minute enough freely to paſs in and out through the pores of glaſs. But then they muſt allow the preſſure of the outward air to be the cauſe of the ſuſpenſion of the quickſilver: for though the *materia cœleſtis* may readily fill the ſpaces the mercury deſerts; yet that within the tube cannot hinder ſo ponderous a liquor from ſubſiding as low as the reſtagnant mercury; ſince all the parts of the tube, as well the lowermoſt as the uppermoſt, being pervious to that ſubtile matter, it may with like facility ſucceed in whatever part of the tube ſhall be forſaken by the quickſilver.

The examiner's ſecond argument in the ſame place is, that ſince the mercurial cylinder is not ſuſtained by the outward air, it muſt neceſſarily be, that it be kept ſuſpended by his internal ſtring. But ſince, for the proof of this he is content to refer us to the third chapter, our having already examined that, allows us to proceed to his third argument, which is, that the mercurial cylinder reſting in its wonted ſtation, does not gravitate; as may appear by applying the finger to the immerſed or lower orifice of the tube. Whence he infers, that it muſt of neceſſity be ſuſpended from within the tube. And indeed if you dexterouſly apply your finger to the open end of the tube, when you have almoſt, but not quite, lifted it out of the reſtagnant mercury, (which circumſtance muſt not be neglected, though our author have omitted it) that ſo you may ſhut up no more quickſilver than the mercurial cylinder is wont to conſiſt of, you will find the experiment to ſucceed well enough; (which makes me ſomewhat wonder to find it affirmed, that the learned *Maignan* denies it:) not but that you will feel upon your finger, a gravitation or preſſure of the glaſs tube, and the contained mercury as of one body; but that you will not feel any ſenſible preſſure of the mercury apart, as if it endeavoured to thruſt away your finger from the tube. But the reaſon of this is not hard to give in our hypotheſis; for according to that, the mercurial cylinder and the air counterpoiſing one another, the finger ſuſtains not any ſenſibly differing preſſure from the ambient air that preſſes againſt the nail and ſides of it, and from the included quickſilver that preſſes againſt the pulp. But if the mercurial cylinder ſhould exceed the uſual length, then the finger would feel ſome preſſure from that ſurpluſage of quickſilver, which the air does not aſſiſt the finger to ſuſtain. So that this pleaſant phænomenon may be as well ſolved in our hypotheſis as in the examiner's: in which, if we had time to clear an objection which we foreſee might be made, but might be anſwered too, we would demand why, when the mercury included in the tube is but of a due altitude, it ſhould run out upon the removal of the finger that ſtops it beneath, in caſe it be ſuſtained only by the internal Funiculus, and do, according to his doctrine, when the Funiculus ſuſtains it, emulate a ſolid body, if the preſſure of the external air has not (as our author teaches it not to have) any thing to do in this matter.

And if ſome inquiſitive perſon ſhall here object, that certainly the finger muſt feel much pain by being ſqueezed between two ſuch preſſures as that of a pillar of thirty inches of quickſilver on the one ſide, and an equivalent preſſure from the atmoſpherical pillar on the other, it may readily be repreſented, that in fluid bodies (ſuch as are thoſe concerned in our difficulty) a ſolid body has no ſuch ſenſe of preſſure from the ambient bodies as (unleſs experience had otherwiſe inſtructed us) we ſhould perhaps imagine. For, not to mention that having inquired of a famous diver, whether he found himſelf ſenſibly compreſſed by the water at the bottom of the ſea; he agreed with the generality of divers in the negative. I am informed that the learned *Maignan* did purpoſely try, that

his

his hand being thruſt three or four palms deep into quickſilver, his fingers were not ſenſible, either of any weight from the incumbent, or of any preſſure from the ambient quickſilver. The reaſon of which (whether that inquiſitive man have given it or no) is not neceſſary, in our preſent controverſy, to be looked after.

To theſe three arguments the examiner adds not a fourth, unleſs he deſigns to preſent
Page 25. it us in this concluding paſſage: *Huc etiam faciunt inſignes librationes, quibus argentum ſubito deſcendens agitatur: Idem enim hic fit, quod in aliis pendulis & ab alto demiſſis fieri ſolet.* 'And 'to this purpoſe make thoſe conſiderable vi-'brations, with which quickſilver is ſtirred in 'its deſcent: for the ſame thing happens here, 'that befalls other pendula in their fall from on 'high.' But of this phænomenon alſo it is eaſy to give an account in our hypotheſis by two ſeveral ways; whereof the firſt (which is proper chiefly when the experiment is made in a cloſe place, as our receiver is,) that the quickſilver by its ſudden deſcent acquires an impetus ſuper-added to the preſſure it has upon the ſcore of its wonted gravity; whereby it, for a while, falls below its ſtation, and thereby compreſſes the air, that leans upon the reſtagnant mercury: which air, by its own ſpring, again forcibly dilating it ſelf to recover its former extenſion, and (as is uſual in ſprings) haſtily flying open, expands it ſelf beyond it, and thereby impels up the quickſilver ſomewhat above its wonted ſtation; in its fall from whence it again acquires ſomewhat (though not ſo much as before) of impetus, or power, to force the corpuſcles of the air to a ſub-ingreſſion; and this reciprocation of preſſure betwixt the quickſilver and the outward air decreaſing by degrees, does at length wholly ceaſe, when the mercury has loſt the ſuper-added preſſure, which it acquired by its falling from parts of the tube higher than its due ſtation. But this firſt way of explicating theſe vibrations is not neceſſary in the free air: for if we conſider the ambient air only as a weight, and remember what we have newly ſaid of the impetus acquired by deſcent; this phænomenon may be eaſily enough explained, by taking notice of what happens in a balance, when one of the equiponderant ſcales chancing to be depreſſed, they do not till after many vibrations ſettle *in æquilibrio.*

AND on this occaſion I ſhall add this experiment: I took a glaſs pipe, whoſe two legs (very unequal in length) were parallel enough, and both perpendicular to that part of the pipe that connected them, (ſuch a ſiphon is deſcribed in our 36th experiment, to find the proportion of the gravity of mercury and water;) into this quickſilver was poured till it was ſome inches high, and equally high in both legs: then the pipe being inclined, till the moſt part of the quickſilver was fallen into one of the legs, I ſtopped the orifice of the other leg with my finger, and erecting again the pipe, though the quickſilver were forced to aſcend a little in that ſtopped leg; yet by reaſon my finger kept the air from getting away, the quickſilver was kept lower by a good deal in that ſtopped leg than in the other; but if, by ſuddenly removing my finger, I gave paſſage to the included and ſomewhat compreſſed air, the preponderant quickſilver in the other leg would, with the mercury in this unſtopped leg, make divers undulations before that liquor did in both legs come to reſt in an æquilibrium. Of which the reaſon may be eaſily deduced from what has been newly delivered; and yet in this caſe there is no pretence to be made of a Funiculus of violently diſtended air to effect the vibrations of the mercury.

CHAP. II.

Divers other difficulties are objected againſt the Funicular Hypotheſis.

THIRDLY, but though our examiner have not ſufficiently proved his hypotheſis, yet perhaps it may be in its own nature ſo like to be true, as to deſerve to be embraced as ſuch. Wherefore we will now take notice of ſome of thoſe many things, that to our apprehenſion render it very improbable.

AND firſt, whereas our author acknowledges, that quickſilver, water, wine and other liquors, will, as well one as another, deſcend in tubes exactly ſealed at the top, in caſe the cylinder of liquor exceed the weight of a mercurial cylinder of 29½ Inches; and will ſubſide no longer than till it is come to equiponderate a cylinder of quickſilver of that height; whereas I ſay, the examiner is, by the ingenious Monſieur *Paſchal*'s, and other experiments, induced to admit this; it cannot but ſeem ſtrange, that, whatever the liquor be, there ſhould be juſt the ſame weight or ſtrength to extend them into a Funiculus: though water, for inſtance, and quickſilver be near fourteen times as heavy one as the other, and be otherwiſe of very diſtant natures; and though divers other liquors, as oil and water, be likewiſe of textures very differing. And this may ſomewhat the more be wondered at, becauſe our author (in his animadverſions upon our 31ſt experiment) is pleaſed to make ſo great a difference betwixt the diſpoſition of bodies of various conſiſtences, as fluid and firm, to be extenuated into a Funiculus, that he will not allow any human force to be able to produce one by the diviſion of two flat marbles, in caſe the contact of their ſurfaces were ſo exquiſite as quite to exclude all air; though in the ſame place his ratiocination plainly enough teaches (which experience however does) that adhering marbles, though with extraordinary difficulty, may be forcibly ſever'd, and according to him, the ſuperficial parts may be diſtended into a Funiculus, that prevents a vacuum.

BUT now the hypotheſis of his adverſaries is not at all incumbered with this difficulty. For the weight of the outward air being that, which keeps liquors ſuſpended in tubes ſealed at the top; it matters not of what nature or texture the ſuſpended liquor is, provided its weight be the ſame with that of a mercurial cylinder equiponderant to the aërial one: as if there be a pound of lead in one ſcale, it will not deſtroy the æquilibrium, whether what be put in the other be gold, or quickſilver, or wool, or feathers, provided its weight be juſt a pound.

In the next place we may take notice, that the account our examiner gives us of his Funiculus in the tenth chapter, (where he takes upon him to explicate it) is much more ſtrange than ſatisfactory, and not made out by any ſuch parallel operations of nature, as his adverſaries will not (and may not well do it) diſpute the truth of. Whereas the weight and ſpring of the air may be inferred from ſuch unqueſtioned experiments, as are not concerned in our preſent controverſy. For the gravity of the air may be manifeſt by a pair of ſcales, and the ſpring of it diſcloſes itſelf ſo clearly in wind-guns and other inſtruments, that our adverſary (as we have already had occaſion to inculcate) does not deny it. But to conſider his explication of his Funiculuss he would have us note two
Page 38. things: firſt, *Argentum, dum replet totum tubum, non mere tangere ejus ſummitatem (ut primo aſpectu videtur) ſed eidem quoque firmiter adhærere. Patet hoc* (ſubjoins he) *experimento illo in primo argumento capitis tertii de tubo utrinque aperto.* 'Quickſilver, while it fills the whole tube, doth 'not only touch its top, (as you would think 'at the firſt ſight) but doth firmly ſtick unto 'it alſo; as it is manifeſt from the experiment 'mentioned in the firſt argument of the third 'chapter, concerning the tube open at both 'ends.' But what is to be anſwered to this proof may be eaſily gathered from what we have replied to that argument. And to what our author adds to prove, that the adheſion of the finger is to the ſubjacent mercury, not
Page 38. the tube; namely, that *licet illud tubi orificium oleo, aliâve materiâ adhæſionem impediente, inungatur, non minus tamen firmiter adhærebit digitus quàm priùs:* 'Though that 'orifice of the tube be anointed with oil, or 'any other matter that will hinder adheſion, 'nevertheleſs the finger will no leſs firmly 'ſtick than before.' An anſwer may be drawn from the ſame place: nor perhaps will his reaſoning much ſatisfy thoſe, who conſider, that bodies by truſion may eaſily enough be made ſtick together, as much as in our caſe the tube and finger do, notwithſtanding one of them is anointed with oil, and that this adheſion of the finger to the tube is to be met with in caſes, where the ſurface of the included quickſilver is not contiguous to the finger, but many inches below. As for what he adds concerning the reaſon, why water and quickſilver aſcend by ſuction, we have already taught what is to be anſwered to it, by aſcribing that aſcenſion to the preſſure of the external air; without any need of having recourſe to a Funiculus; or imagining with him in this place, that becauſe nothing beſides the water or quickſilver can in ſuch caſes ſucceed the air, (which yet is not eaſy to be proved in reference to a thin æthereal ſubſtance,) therefore,
Page 40. *Partes ipſius aëris* (to uſe his expreſſion) *ſic tubo incluſæ (quæ aliàs tam facile ſeparantur) nunc tam fortiter ſibi invicem agglutinentur, ut validiſſimam (uti videmus) conficiunt catenam, qua non ſolum aqua, ſed ponderoſum illud argentum ſic in altum trahatur:* 'That the parts of air itſelf ſo ſhut up 'in the tube (which otherwiſe are ſo eaſily ſe-'ver'd) are now ſo firmly glued to one an-'other, that they make (as we ſee) a ſtrong 'chain, by which not only water but even 'weighty quickſilver is drawn on high.' Which way of wreathing a little rarefied air into ſo ſtrong a rope, how probable it is, I will for a while leave the reader to judge, and advance to our author's ſecond notandum, which he thus propoſes:

Rarefactionem ſive extenſionem corporis ad oc- Page 40, *cupandum majorem locum fieri non ſolo calore,* 41. *ſed etiam diſtenſione ſeu vi divulſivâ; ſicut è contra condenſatio non ſolo frigore perficitur, ſed etiam compreſſione, uti innumera paſſim docent exempla:* 'That the rarefaction or extenſion of a body, 'ſo as to make it take up more ſpace, is not only 'made by heat, but by diſtenſion or a certain diſ-'joining power; as, on the contrary, conden-'ſation is not only made by cold, but alſo by 'compreſſion, as infinite examples bear us 'witneſs.' And it is true and obvious, that the condenſation of bodies, taking that word in a large ſenſe, may be made as well by compreſſion as cold. But I wiſh he had more clearly expreſſed what he means in this place by that rarefaction, which he ſays is to be made by diſtenſion, or a *vis divulſiva*, whereof he tells us there are innumerable inſtances. For, as far as may be gathered from the three examples he ſubjoins, it is only the air, that is capable of being ſo extended as his hypotheſis requires quickſilver and even ſtones muſt be. And I know not how it will be proved, that even air may be thus extended ſo far, as in the *Magdeburg* experiment, to fill a place more than two thouſand times as big as that it filled before. For that the ſame air in this and his two foregoing inſtances does adequately fill more ſpace at one time than another, he proves but by the ruſhing in of water into the evacuated glaſs, and filling it within a little quite full, which, he ſays, is done by the diſtended air, that contracting itſelf draws up the water with it. Which explication how much leſs likely it is, than that the water is in ſuch caſes impelled up by the preſſure of the atmoſphere, we ſhall anon (when we come to diſcuſs his way of rarefaction and condenſation) have occaſion to examine. In the mean time let us conſider with him the explication, which, after having promiſed the two above recited obſervations, he gives us of his Funiculus; *Cum per primum notandum argen-* Page 41. *tum ita adhæreat tubi vertici, & per ſecundum, rarefactio fiat per meram corporis diſtenſionem, ita rem ſe habere, ut argentum deſcendens à vertice tubi affixam ei relinquat ſuperficiem ſuam extimam ſive ſupremam, eamque eouſque ſuo pondere extendat extenuetque, donec facilius ſit aliam ſuperficiem ſimiliter relinquere quam priorem illam ulterius extendere: Secundam igitur relinquit, eamque eodem modo deſcendendo extendit, donec facilius ſit tertiam adhuc ſeparari quam illam ſecundam extendere ulterius; & ſic deinceps, donec tandem vires amplius non habeat ſuperficies ſic ſeparandi & extendendi; nempe donec perveniat ad altitudinem digitorum duntaxat 29½. ubi quieſcit, ut capite primo dictum eſt.* 'Seeing by 'the firſt note it is manifeſt, that the quickſil-'ver doth ſo ſtick to the top of the tube, and 'by the ſecond note the rarefaction is made only

'only by the mere diſtenſion of the body; it ſo 'comes to paſs, that the deſcending quickſilver 'leaves its external or upper ſuperficies fixed un- 'to the top of the tube, and by its weight doth 'ſo ſtretch and extenuate it, until it becomes 'eaſier to leave another ſuperficies in like man- 'ner, than to extend that any further. It leaves 'therefore a ſecond, and doth by its deſcent ex- 'tend that a little further, until it becomes eaſier 'to ſeparate a third than to extend that any fur- 'ther; and ſo forwards, until at length it hath no 'power to ſeparate or extend any more ſuper- 'ficies, namely, until it comes unto the height 'of 29 inches and an half; where it acquieſces, 'as we have declared in the firſt chapter.' Thus far our examiner's explication: by which it is eaſy to diſcern, that he is fain to aſſign his Funiculus a way of being produced ſtrange and unparallelled enough. For, not to repeat our animadverſions upon the firſt of the two notandum's, on which the explication is grounded, I muſt demand by what force, upon the bare ſeparation of the quickſilver and the top of the tube, the new body he mentions comes to be produced; or at leaſt how it appears, that the mercury leaves any ſuch thing as he ſpeaks of behind it. For the ſenſe perceives no ſuch matter at the top of the tube, nor is it neceſſary to explicate the phænomena as we have formerly ſeen. It may alſo be marvelled at, that the bare weight of the deſcending mercury ſhould be able to extend a ſurface into a body. And beſides, it ſeems precariouſly affirmed, that there is ſuch a ſucceſſive leaving behind of one ſurface after another as is here imagined: nor does it at all appear how, though ſome of the quickſilver were turned into a thin ſubtile ſubſtance, yet that ſubſtance comes to be contrived into a Funiculus of ſo ſtrange a nature, that ſcarce any weight (for aught appears by his doctrine) can be able to break it; that contrary to all other ſtrings it may be ſtretched without being made more ſlender; and that it has other very odd properties, ſome of which we ſhall anon have occaſion to mention. As for what our author ſubjoins in theſe words,

Page 43, 44. *Eodem itaque ferè modo ſeparari videntur hæ ſuperficies ab argento deſcendente, & in tenuiſſimum quendam funiculum per deſcendens pondus extendi, quo per calorem in accenſa candela ſeparantur hujuſmodi ſuperficies à ſubjecta cera aut ſevo, & in ſubtiliſſimam flammam extenuantur. Ubi notatu dignum, quemadmodum flamma illa pluſquam millies ſine dubio majus ſpatium occupat, quam antea occupaverat pars illa ceræ, ex qua conficitur; ita prorſus & hic exiſtimandum, Funiculum illum pluſquam millies majus ſpatium occupare, quàm prius occupaverat illa argenti particula, ex qua fit exortus: uti etiam ſine dubio contingit, quando talis particula à ſubjecto igne in vaporem convertitur.* 'Theſe ſurfaces ſeem 'to be ſeparated from the quickſilver, and to 'be extended into a moſt ſlender ſtring by the 'weight that falls down, after the ſame man- 'ner that in a lighted candle ſurfaces of like 'ſort are ſeparated from the wax or tallow un- 'derneath by the heat above, and are extenu- 'ated into a moſt ſubtile flame. In which it 'is worth obſervation, that as that flame doth 'doubtleſs take up more than a thouſand times 'a greater ſpace than the part of the wax, of 'which the flame was made, took up; ſo is it 'here to be thought, that that ſtring doth take 'up a ſpace more than a thouſand times as big 'as that, which the ſmall particle of mercury, 'from whence it aroſe, did before take up. As 'alſo it doubtleſs happens, when ſuch a particle 'by a fire underneath is turned into a vapour.' Though it be the only example, whereby he endeavours to illuſtrate the generation of his Funiculus, yet (I preſume) he ſcarce expects we ſhould think it an oppoſite one. For beſides that there here intervenes a conſpicuous and powerful agent, namely, an actual fire to ſever and agitate the parts of the candle; and beſides that there is a manifeſt waſting of the wax or tallow turned into flame; beſides theſe things, I ſay, we muſt not admit, that the fuel, when turned into a flame, does really fill (I ſay, not, with our author) more than a thouſand times, but ſo much as twice more of genuine ſpace than the wax it was made of. For it may be ſaid, that the flame is little or nothing elſe than an aggregate of thoſe corpuſcles, which before lay upon the upper ſuperficies of the candle, and by the violent heat were divided into minuter particles, vehemently agitated and brought from lying as it were upon a flat to beat off one another, and make up about the wick ſuch a figure, as is uſual in the flame of candles burning in the free air. Nor will it neceſſarily follow, that the ſpace, which the flame ſeems to take up, ſhould contain neither air nor æther, nor any thing elſe, ſave the parts of that flame, becauſe the eye cannot diſcern any other body there: for even the ſmoke aſcending from the ſnuff of a newly-extinguiſhed candle appears a dark pillar, which to the eye at ſome diſtance ſeems to conſiſt of ſmoke; when as yet there are ſo many aerial and other inviſible corpuſcles mingled with it, as if all thoſe parts of ſmoke, that make a great ſhow in the air, were collected and contiguous, they would not perhaps amount to the bigneſs of a pin's head, as may appear by the great quantity of ſtreams, that in chymical veſſels are wont to go to the making up of one drop of ſpirit. And therefore it does not ill fall out for our turn, that the examiner, to inforce his former example, alledges the turning of a particle of quickſilver into vapour, by putting fire under it: for if ſuch be the rarefaction of mercury, it is not at all like to make ſuch a Funiculus as he talks of, ſince thoſe mercurial fumes appear by divers experiments to be mercury divided and thrown abroad into minute parts, whereby though the body obtain more of ſurface than it had before, yet it really fills no more of true and genuine ſpace; ſince if all the particular little ſpaces filled by theſe ſcattered corpuſcles were reduced into one, (as the corpuſcles themſelves often are in chymical operations) they would amount but to one total ſpace, equal to that of the whole mercury before rarefaction. But theſe objections againſt this explication are not all that I have to ſay againſt our adverſary's Funiculus itſelf.

FOR I farther demand, how the Funiculus comes

comes by ſuch hooks or grapple-irons, or parts of the like ſhape, to take faſt hold of all contiguous bodies, and even the ſmootheſt, ſuch as glaſs, and the calm ſurface of quickſilver, water, oil, and other fluids: and how theſe ſlender and inviſible hooks cannot only in the terſeſt bodies find an innumerable company of ears or loops to take hold on, but hold ſo ſtrongly, that they are able not alone to lift up a tall cylinder of that very ponderous metal of quickſilver, but to draw inwards the ſides of ſtrong glaſſes ſo forcibly, as to break them all to pieces. And it is alſo ſomewhat ſtrange, that water and other fluid bodies (whoſe parts are wont to be ſo eaſily ſeparable) ſhould, when the Funiculus once lays hold on the ſuperficial corpuſcles, preſently emulate the nature of conſiſtent bodies, and be drawn up like maſſes each of them of an intire piece; though even in the exhauſted receiver they appear by their undulation (when they are ſtirred by bubbles that paſs freely through them) and many other ſigns to continue fluid bodies.

It ſeems alſo very difficult to conceive, how this extenuated ſubſtance ſhould require ſo ſtrong a ſpring inward, as the examiner all along his books aſcribes to it. Nor will it ſerve his turn to require of us in exchange an explication of the air's ſpring outward, ſince he acknowledges, as well as we, that it has ſuch a ſpring. I know, that by calling this extenuated ſubſtance a Funiculus, he ſeems plainly to intimate, that it has its ſpring inward, upon the ſame account that lute-ſtrings and ropes forcibly ſtretched have theirs. But there is no ſmall diſparity betwixt them: for whereas in ſtrings there is required either wreathing, or ſome peculiar and artificial texture of the component parts; a rarefaction of air (were it granted) does not include or infer any ſuch contrivance of parts as is requiſite to make bodies elaſtical. And if the Carteſian notion of the cauſe of ſpringineſs be admitted, then our extenuated ſubſtance having no pores to be pervaded by the *materia ſubtilis* (to which beſides our author alſo makes glaſs impervious) will be deſtitute of ſpringineſs. And however, ſince lute-ſtrings, ropes, &c. muſt, when they ſhrink inwards, either fill up or leſſen their pores, and increaſe in thickneſs as they diminiſh in length; our examiner's Funiculus muſt differ very much from them, ſince it has no pores to receive the ſhrinking parts, and contracts itſelf as to length, without increaſing its thickneſs. Nor can it well be pretended, that this ſelf-contraction is done *ob fugam vacui*, ſince though it ſhould not be made, a vacuum would not enſue. And if it be ſaid, that it is made, that the præternaturally ſtretched body might reſtore itſelf to its natural dimenſions; I anſwer, that I am not very forward to allow acting for ends to bodies inanimate, and conſequently devoid of knowledge; and therefore ſhould gladly ſee ſome unqueſtionable examples produced of operations of that nature. And however to me, who in phyſical inquiries of this nature look for efficient rather than final cauſes, it is not eaſy to conceive, how air, by being expanded, (in which caſe its force, like that of other rarefied bodies, ſeems principally to tend outwards, as we ſee in fired gunpowder, in æolipiles, in warmed weather-glaſſes, &c.) ſhould acquire ſo prodigious a force of moving contiguous bodies inwards. Nor does it to me ſeem very probable, that, when for inſtance part of a poliſhed marble is extended into a Funiculus, that Funiculus does ſo ſtrongly aſpire to turn into marble again. I might likewiſe wiſh our author had more clearly explicated, how it comes to paſs (which he all along takes for granted) that the acceſs of the outward air does ſo much and ſo ſuddenly relax the tenſion of his Funiculus; ſince that being (according to him) a real and poreleſs body, it is not ſo obvious, how the preſence of another can ſo eaſily and to ſo ſtrange a degree make it ſhrink. But I will rather obſerve, that it is very unlikely, that the ſpace, which our adverſary would have repleniſhed with his funicular ſubſtance, ſhould be full of little highly ſtretched ſtrings, that lay faſt hold of the ſurfaces of all contiguous bodies, and always violently endeavour to pull them inwards. For we have related in our 26th experiment, that a pendulum being ſet a moving in our exhauſted receiver, did ſwing to and fro as freely, and with the ſtring ſtretched as ſtreight, as, for aught we could perceive, it would have done in the common air. Nay, the balance of a watch did there move freely and nimbly to and fro; which it is hard to conceive thoſe bodies could do, if they were to break through a medium conſiſting of innumerable exceedingly ſtretched ſtrings. On which occaſion we might add, that it is ſomewhat ſtrange, that theſe ſtrings, thus cut or broken by the paſſage of theſe bodies through them, could ſo readily have their parts re-united, and without any more ado be made intire again. And we might alſo take notice of this as another ſtrange peculiarity in our author's Funiculus, that in this caſe the two divided parts of each ſmall ſtring, that is broken, do not, like thoſe of other broken ſtrings, ſhrink and fly back from one another; but (as we juſt now ſaid) immediately redintegrate themſelves: whereas, when in the Torricellian experiment the tube and contained mercury is ſuddenly lifted up out of the reſtagnant quickſilver into the air, the Funiculus does ſo ſtrangely contract itſelf, that it quite vaniſhes; inſomuch that the aſcending mercury may riſe to the very top of the tube. Theſe, I ſay, and divers other difficulties might on this occaſion be inſiſted on; but that, ſuppoſing our ſelves to have mentioned enough of them for once, we think it now more ſeaſonable to proceed to the remaining part of our diſcourſe.

CHAP. III.

The Ariſtotelian Rarefaction (propoſed by the adverſary) examined.

BUT this is not all, that renders the examiner's hypotheſis improbable; for beſides thoſe already mentioned particulars, upon whoſe ſcore it is very difficult to be underſtood, it neceſſarily ſuppoſes ſuch a rarefaction and condenſation,

denſation, as is, I confeſs, to me, as well as to many other conſidering perſons, unintelligible.

FOR the better diſcernment of the force of this objection, we muſt briefly premiſe, that a body is commonly ſaid to be rarefied or dilated, (for I take the word in a larger ſenſe than, I know, many others do, for a reaſon that will quickly appear) when it acquires greater dimenſions than the ſame body had before; and to be condenſed, when it is reduced into leſs dimenſions, that is, into a leſſer ſpace than it contained before; as when a dry ſponge being firſt dipped in water ſwells to a far greater bulk, and then being ſtrongly ſqueezed and held compreſſed, is not only reduced into leſs room than it had before it was ſqueezed, but into leſs than it had even before it was wetted. And I muſt further premiſe, that rarefaction (as alſo condenſation) being amongſt the moſt obvious phænomena of nature, there are three (and for aught we know but three) ways of explicating it: for, either we muſt ſay with the Atomiſts and Vacuiſts, that the corpuſcles, whereof the rarefied body conſiſts, do ſo depart from each other, that no other ſubſtance comes in between them to fill up the deſerted ſpaces that come to be left betwixt the incontiguous corpuſcles; or elſe we muſt ſay with divers of the ancient philoſophers, and many of the moderns, eſpecially the Carteſians, that theſe new intervals produced betwixt the particles of the rarefied body are but dilated pores, repleniſhed, in like manner as thoſe of the tumid ſponge are, by the imbibed water, by ſome ſubtile æthereal ſubſtance, that inſinuates itſelf betwixt the disjoined particles: or, laſtly, we muſt imagine, with *Ariſtotle* and moſt of his followers, that the ſelf-ſame body does not only obtain a greater ſpace in rarefaction, and a leſſer in condenſation, but adequately and exactly fill it, and ſo when rarefied acquires larger dimenſions without either leaving any vacuities betwixt its component corpuſcles, or admitting between them any new or extraneous ſubſtance whatſoever.

Now it is to this laſt (and, as ſome call it, rigorous) way of rarefaction, that our adverſary has recourſe in his hypotheſis; though this, I confeſs, appears to me ſo difficult to be conceived, that I make a doubt whether any phænomenon can be explained by it; ſince to explain a thing is to deduce it from ſomething or other in nature more known than itſelf.

HE that would meet with full diſcuſſions of this Ariſtotelian rarefaction, may reſort to the learned writings of *Gaſſendus*, *Carteſius* and *Maignan*, who have accuſed it of divers great abſurdities: but for my part, I ſhall at preſent content my ſelf to make uſe, to my purpoſe, of two or three paſſages, that I meet with (though not together) in our author himſelf.

LET us then ſuppoſe, that in the *Magdeburgh* experiment he ſo often (though I think cauſleſly enough) urges to prove his hypotheſis; let us (I ſay) for eaſier conſideration's ſake ſuppoſe, that the undilated air, which (as he tells us) poſſeſſed about half an inch of ſpace, conſiſted of a hundred corpuſcles, or (if that be in this caſe diſliked) a hundred parts; (for it matters not what number we pitch upon) and it will not be denied, but that as the whole parcel of air, or the aggregate of this hundred corpuſcles, is adequate to the whole ſpace it fills, ſo each of the hundred parts, that make it up, is likewiſe adequately commenſurate to its peculiar ſpace, which we here ſuppoſe to be a hundredth part of the whole ſpace. This premiſed, our author having elſewhere this paſſage, *Corpore occupante locum ver-* Page 160. *bi gratia duplo majorem, neceſſe eſt, ut quælibet ejus pars locum quoque duplo majorem occupet*; 'A body taking up a place, for inſtance, twice 'as big at it ſelf; it is of neceſſity that every 'part of it muſt likewiſe take up a place twice 'as big as it ſelf: prompts us to ſubjoin, that in the whole capacity of the globe (which according to him was two thouſand times as great as the room poſſeſſed by the unexpanded air) there muſt likewiſe be two hundred thouſand parts of ſpace commenſurate each of them to one of the fore-mentioned hundredth parts of air; and conſequently, when he affirms, that that half-inch of air poſſeſſed the whole cavity of the globe, if we will not admit (as he does not) either vacuities, or ſome intervening ſubtile ſubſtance in the interval of the aërial parts, he muſt give us leave to conclude, that each part of air does adequately fill two thouſand parts of ſpace. Now that this ſhould be reſolutely taught to be not only naturally poſſible, (for we diſpute not here of what the divine Omnipotence can do) but to be really and regularly done in this *Magdeburgh* experiment, will queſtionleſs appear very abſurd to the Carteſians and thoſe other philoſophers, who take extenſion to be but notionally different from body, and conſequently impoſſible to be acquired or loſt without the addition or detraction of matter; and will, I doubt not, appear ſtrange to thoſe other readers, who conſider how generally naturaliſts have looked upon extenſion as inſeparable, and as immediately flowing from matter; and upon bodies, as having neceſſary relation to a commenſurate ſpace. Nor do I ſee, if one portion of air may ſo eaſily be brought exactly to fill up a ſpace two thouſandt imes as big as that, which it did but fill before without the addition of any newſubſtance; I ſee not (I ſay) why the matter contained in every of theſe two thouſand parts of ſpace may not be further brought to fill two thouſand more, and ſo onwards, ſince each of theſe newly-repleniſhed ſpaces is preſumed to be exactly filled with body, and no ſpace, nor conſequently that which the unrarefied air repleniſhed, can be more than adequately full. And ſince, according to our adverſary, not only fluid bodies, as air and quickſilver, but even ſolid and hard ones, as marble, are capable of ſuch a diſtenſion as we ſpeak of, why may not the world be made I know not how many thouſand times bigger than it is, without either admitting any thing of vacuity betwixt its parts, or being increaſed with the addition of one atom of new matter? Which to me is ſo difficult to conceive, that I have ſometimes doubted, whether, in caſe it could be proved, that in the exhauſted globe we ſpeak

Page 42.

of, there were no vacuities within, nor any ſubtile matter permitted to enter from without, it were, not more intelligible to ſuppoſe, that God had created a new matter to join with the air in filling up the cavity, than that the ſelf-ſame air ſhould adequately fill two thouſand ſpaces, whereof one was exactly commenſurate to it, even when it was uncompreſſed. For divers eminent Naturaliſts, both ancient and modern, believing, upon a phyſical account, the ſouls of men to be created and infuſed, will admit it as intelligible, that God does frequently create ſubſtances on certain emergent occaſions. But I know that many of them will not likewiſe think it conceivable, that without his immediate interpoſition an acceſſion of new, real dimenſions ſhould be had without either vacuities or acceſſion of matter.

And indeed when I conſidered theſe difficulties and others, that attend the rarefaction our examiner throughout his whole book ſuppoſes, and when I found that ever and anon he remits us to what he teaches concerning rarefaction; I could not but with ſome greedineſs reſort to the chapters he addreſſed me to. But when I had peruſed them, I found the difficulties remained ſuch ſtill, and that it was very hard even for a witty man to make more of a ſubject than the nature of it does bear. Which I ſay, that by profeſſing my ſelf unſatisfied with what he writes, I may not be thought to find fault with a man for not doing what perhaps is not to be done, and for not making ſuch abſtruſe notions plain, as are ſcarcely (if at all) ſo much as intelligible. And indeed as he has handled this ſubject modeſtly enough, ſo in ſome places his expreſſions are to me ſomewhat dark; which I mention, not to impute it as a crime in him, that he wrote in a diffident and doubtful ſtrain of ſo difficult a matter; but to excuſe my ſelf, if I have not always gueſſed aright at his meaning.

The things he alledges, in favour of the rarefaction he would perſuade, are two: the one, that the phænomena of rarefaction cannot be explicated either by vacuities or the ſubingreſſion of an æthereal ſubſtance; and the other, that there are two ways of explicating the rigorous rarefaction he contends for.

His objections againſt the Epicurean and Carteſian ways of making out rarefaction are ſome of them more plauſible than moſt of thoſe, that are wont to be urged againſt them; yet not ſuch as are not capable enough of anſwers. But whilſt ſome of the paſſages appeared eaſy to be replied to by the favourers of the hypotheſis they oppoſe, before I had fully examined the reſt, chancing to mention theſe chapters to an ingenious man, hereafter to be further mentioned in this treatiſe, he told me he had ſo far conſidered them more than the reſt of the book, that he had thought upon ſome hypotheſes, whereby the phænomena of rarefaction might be made out either according to the Vacuiſts, or according to the Carteſians, adding, that he had alſo examined the inſtance our adverſary pretends to be afforded him of his rarefaction by what happens in the *Rota Ariſtotelica*. Wherefore being ſufficiently diſtreſſed by avocations of ſeveral ſorts, and being willing to reſerve the declaration of my own thoughts concerning the manner of rarefaction and condenſation for another treatiſe, I ſhall refer the reader to the ingenious conjectures about this ſubject, which the writer of them intends to annex to the preſent diſcourſe; and only add in general, that whereas the examiner's argument on this occaſion is, that his way of rarefaction muſt be admitted, becauſe neither of the other two can be well made out; his adverſaries may with the ſame reaſon argue, that one of theirs is to be allowed, ſince his is incumbered with ſuch manifeſt difficulties. And they may enforce what they ſay by repreſenting, that the inconveniences, that attend his hypotheſis about rarefaction, are inſuperable, ariſing from the unintelligible nature of the thing it ſelf; whereas thoſe, to which the other ways are obnoxious, may ſeem to ſpring but from men's not having yet diſcovered, what kind of figures and motions of the ſmall particles may beſt qualify them to make the body, that conſiſts of them, capable of a competent expanſion.

After our author's objections againſt the two ways of rarefaction propoſed, the one by the Vacuiſts, and the other by the Carteſians and others, that admit the ſolideſt bodies, and even glaſs it ſelf, to be pervious to an æthereal or ſubtile matter; he attempts to explicate the manner, by which that rigorous rarefaction he teaches is performed: and having premiſed, that the explication of the way, how each part of the rarefied body becomes extended, depends upon the quality of the parts, into which the body is ultimately reſolved; and having truly obſerved, that they muſt neceſſarily be either really indiviſible, or ſtill endleſly diviſible; he endeavours to explicate the Ariſtotelian rarefaction according to thoſe two hypotheſes. But, though he thus propoſe two ways of making out his rarefaction; yet beſides that they are irreconcilable, he ſpeaks of them ſo darkly and doubtfully, that it ſeems leſs eaſy to diſcern, which of the two he would be content to ſtick to, than that he himſelf ſcarce acquieſces in either of them.

And, firſt, having told us, how rarefaction may be explained, in caſe we admit bodies to be diviſible *in infinitum*, he does himſelf make ſuch an objection againſt the infinity of parts in a *continuum*, as he is fain to give ſo obſcure an anſwer to, that I confeſs I do not underſtand it; and preſume, that not only the moſt part of unprejudiced readers will as little acquieſce in the anſwer as I do; but even the author himſelf will not marvel at my confeſſion, ſince in the ſame place he acknowledges the anſwer to be ſomewhat obſcure, and endeavours to excuſe its being ſo, becauſe in that hypotheſis it can ſcarce be otherwiſe.

Wherefore I ſhall only add on this occaſion, that it is not clear to me, that even ſuch a diviſibility of a *continuum* as is here ſuppoſed would make out the rarefaction he contends for. For, let the integrant parts of a *continuum* be more or leſs finite or infinite in number, yet ſtill each part, being a corporeal ſubſtance, muſt have ſome particle of ſpace com-

commenſurate to it; and if the whole body be rarefied, for inſtance, to twice its former bigneſs, then will each part be likewiſe extended to double its former dimenſions, and fill both the place it took up before, and another equal to it, and ſo two places.

THE ſecond argument alledged to recommend the hitherto-mentioned way of explicating rarefaction is, that many learned men, amongſt whom he names two, *Aquinas* and *Suarez*, have taught, that the ſame corporeal thing may naturally be, and *de facto* often is, in the ſouls of brutes really indiviſible and virtually extended. But, though I pay thoſe two authors a juſt reſpect for their great ſkill in ſcholaſtical and metaphyſical learning; yet the examiner cannot ignore, that I could make a long catalogue of writers, both ancient and modern, at leaſt as well verſed in natural philoſophy as Saint *Thomas* and *Suarez*, who have ſome of them in expreſs words denied this to be naturally poſſible; and others have declared themſelves of the ſame judgment by eſtabliſhing principles, with which this conceit of the virtual extenſion of the indiviſible corpuſcles is abſolutely inconſiſtent. And though no author had hitherto oppoſed it, yet I, that diſpute not what this or that man thought, but what it is rational to think, ſhould nevertheleſs not ſcruple to reject it now; and ſhould not doubt to find ſtore of the beſt Naturaliſts of the ſame opinion with me, and perhaps among them the examiner himſelf, who (however this acknowledgment may agree with the three following chapters of his book) tells us, (pag. 160.) that *juxta probabiliorem ſententiam hujuſmodi virtualis extenſio rei corporeæ concedenda non eſt, utpotè ſoli rei ſpirituali propria:* 'According to the more probable opinion, ſuch a virtual extenſion of a corporeal being is not to be granted, as being only proper to ſuch as are ſpiritual.'

BUT to conclude at length this tedious inquiry into the Ariſtotelian way of rarefaction, (which is of ſo obſcure a nature, that it can ſcarce be either propoſed or examined in few words) I will not take upon me reſolutely to affirm, which of the two ways of explicating it (by atoms or by parts infinitely diviſible) our author declares himſelf for. But which of them ſoever it be, I think I have ſhown, that he has not intelligibly made it out: and I make the leſs ſcruple to do ſo, becauſe he himſelf is ſo ingenuous as (at the cloſe of his diſcourſe of the two ways) to ſpeak thus of the opinion he pre- *Pag. 169.* fers; *Præſtat communi & receptæ hactenus in ſcholis ſententiæ inſiſtere, quæ licet difficultates quidem non clarè ſolvat, iis tamen apertè non ſuccumbit:* 'It is better to continue in the common opinion, which hath been hitherto received in the ſchools; which although it doth not clearly reſolve all difficulties, yet it doth not openly lie under them.' So that in this diſcourſe of rarefaction, to which our author has ſo often in the foregoing part of the book referred us, as that which ſhould make good what there ſeemed the moſt improbable; he has but, inſtead of a probable hypotheſis needleſly rejected, ſubſtituted a doctrine, which himſelf dares not pretend capable of being well freed from the difficulties, with which it may be charged; though I doubt not but other readers, eſpecially Naturaliſts, will think he has been very civil to this obſcure doctrine, in ſaying that *difficultatibus non apertè ſuccumbit.*

AS for the other way of explicating rarefaction, namely, by ſuppoſing that a body is made up of parts indiviſible; he will not, I preſume, deny, but that the objections we formerly made againſt it are weighty. For according to this hypotheſis, (which one would think he prefers, ſince he makes uſe of it in the three or four laſt chapters of his book,) *Neceſſariò fatendum eſt* (ſays he) *unam eandemque partem poni in duplici loco adæquate: cum enim indiviſibilis ſit, locumque occupet majorem quam prius, neceſſe eſt, ut tota ſit in quolibet puncto totius loci, ſive ut per totum illud ſpatium virtualiter extendatur:* 'We muſt needs confeſs, that one and the ſame part muſt be in two places adequately. For ſeeing it is indiviſible, and takes up a greater place than before, it muſt of neceſſity be all in every point of that place, or that be virtually extended through all that ſpace.' So that when he in the very next page affirms, that by this virtual extenſion of the parts, the difficulties, that have for ſo many ages troubled philoſophers, may be eaſily ſolved, he muſt give me leave (who love to ſpeak intelligibly, and not to admit what I cannot underſtand) to deſire he would explain to me what this *extenſio virtualis* is, and how it will remove the difficulties that, I formerly charged upon the Ariſtotelian rarefaction. For the eaſier conſideration of this matter, let us reſume what we lately ſuppoſed; namely, that in the Magdeburgick experiment the half-inch of undilated air conſiſted of a hundred corpuſcles: I demand how the indiviſibility of theſe corpuſcles will qualify them to make out ſuch a rarefaction as the author imagines. For what does their being indiviſible do in this caſe, but make it the leſs intelligible, how they can fill above a hundred parts of ſpace? It is eaſy to foreſee he will anſwer, that they are virtually extended. But not here to queſtion, how their indiviſibility makes them capable of being ſo; I demand, whether by an atom's being virtually extended, its corporeal ſubſtance do really (I mean adequately) fill more ſpace than it did before, or whether it do not: (for one of the two is neceſſary.) If it do, then it is a true and real, and not barely a virtual extenſion. And that ſuch an extenſion will not ſerve the turn, what we have formerly argued againſt the Peripatetick rarefaction will evince; and our adverſary ſeems to confeſs as much, by deviſing this virtual extenſion to avoid the inconveniences, to which he ſaw his doctrine of rarefaction would otherwiſe plainly appear expoſed. But if it be ſaid, that when an atom is virtually extended, its corporeal ſubſtance fills no more ſpace than before; this is but a verbal ſhift, that may perhaps amuſe an unwary reader, but it will ſcarce ſatisfy a conſidering one. For I demand how that which is not a ſubſtance can fill place; and how this improper and but metaphorical extenſion will *Pag. 163.*

ſolve

ſolve the phænomena of rarefaction: as how the half-inch of air at the top of the forementioned globe ſhall without a corporeal extenſion fill the whole globe of two thouſand times its bigneſs, when the water is ſucked out of it, and act at the lower part of the globe. Which laſt clauſe I therefore add, becauſe not only our author teaches (pag. 91, and 92.) that the whole globe was filled with a certain thin ſubſtance, which by its contraction violently ſnatched up the water into which the neck of the glaſs was immerſed; but in a parallel caſe he makes it his grand argument to prove, that there is no vacuum in the deſerted part of the *Chap. 5.* tube in the Torricellian experiment, that the attraction of the finger cannot be performed but by ſome real body. Wherefore till the examiner does intelligibly explain, how a virtual extenſion, as it is oppoſed to a corporeal, can make an atom fill twice, nay, two thouſand times more ſpace than it did before; I ſuppoſe this device of virtual extenſion will appear to unbiaſſed Naturaliſts but a very unſatisfactory evaſion.

Two arguments indeed there are, which our adverſary offers as proofs of what he teaches. The firſt is, that they commonly teach in the ſchools, that at leaſt *divinitus* (as he ſpeaks) ſuch a thing as is pleaded for may be done, and that conſequently it is not repugnant to the nature of a body. But, though they that either know me, or have read what I have written about matters theological, will, I hope, readily believe, that none is more willing to acknowledge and venerate Divine Omnipotence; yet in ſome famous ſchools they teach, that it is contrary to the nature of the thing. And that men, who think ſo, and conſequently look not upon it as an object of Divine Omnipotence, may (whatever he here ſay) without impiety be of a differing mind from him about the poſſibility of ſuch a rarefaction as he would here have, our author may, perchance, think fit to grant, if he remembers that he himſelf ſays *Page 175.* a few pages after, *Cum tempus ſit Ens eſſentialiter ſucceſſivum, ita ut ne divinitùs quidem poſſint duæ ejus partes ſimul exiſtere, &c.* 'Seeing 'time is a being eſſentially ſucceſſive, ſo that 'neither by divine power can two of its parts 'exiſt together.' But, not now to diſpute of a power, that I am more willing to adore than queſtion, I ſay, that our controverſy is not what God can do, but about what can be done by natural agents, not elevated above the ſphere of nature. For though God can both create and annihilate, yet nature can do neither: and in the judgement of true philoſophers, I ſuppoſe our hypotheſis would need no other advantage, to make it be preferred before our adſaries, than that in ours things are explicated by the ordinary courſe of nature, whereas in the other recourſe muſt be had to miracles.

But, though our author's way of explicating rarefaction be thus improbable, yet I muſt not here omit to take notice, that his Funiculus ſuppoſes a condenſation, that to me appears incumbered with no leſs manifeſt difficulties. For, ſince he teaches, that a body may be condenſed without either having any vacuities for the compreſt parts to retire into, or having pores filled with any ſubtile and yielding matter, that may be ſqueezed out of them; it will follow, that the parts of the body to be condenſed do immediately touch each other: which ſuppoſed, I demand how bodies, that are already contiguous, can be brought to farther approximations without penetrating each other, at leaſt in ſome of their parts. So that I ſee not how the examiner's condenſation can be performed without penetration of dimenſions; a thing that philoſophers of all ages have looked upon as by no means to be admitted in nature. And our author himſelf ſpeaks ſomewhere at the ſame rate, where to the queſtion, Why the walls that incloſe fired gun-powder muſt be blown aſunder? *Reſpondeo* (ſays he) *hæc omnia inde acci-* *Page 159.* *dere, quod pulvis ille ſic accenſus & in flammam converſus, longe majus ſpatium nunc occupet quàm prius. Unde fit, ut cum totum cubiculum antea fuerit pleniſſimum, diſrumpantur ſic parietes, ne detur corporum penetratio.* 'I anſwer, that all 'theſe things happen becauſe the gun-powder 'ſo kindled and turned into flame takes up a 'much greater ſpace than before. Whence it 'comes to paſs, that ſeeing the chamber was be-'fore quite full, by this means the walls are 'broken, that there may be no penetration of 'bodies.' In the Magdeburgick experiment he tells us (as we have heard already) that the whole capacity of the globe is filled with an extremely thin body. But not now to examine how properly he calls that a rare body, which according to him intercepts neither pores nor any heterogeneous ſubſtance, the greater or leſſer abſence of which makes men call a body more or leſs denſe; not to inſiſt on this, I ſay, let us conſider, that before the admiſſion of water into the exhauſted globe, there was, according to him, two thouſand half-inches of a ſubſtance, which, however it was produced or got thither, was a true and real body; and that after the admiſſion of the water, there remained in the ſame globe, beſides the water that came in, no more than one half inch of body. Since then our author does not pretend (which if he did, might be eaſily diſproved) that one thouſand nine hundred ninety-nine half-inches of matter, that now appear no more, traverſed the body of water; ſince he will not allow, that it gets away through the pores of the glaſs, I demand, what becomes of ſo great a quantity of matter? For that it is annihilated, I ſuppoſe he is too rational a man to pretend, (nor, if he ſhould, would it be at all believed;) and to ſay, that a thouſand and ſo many hundred parts of matter ſhould be retired into that one part of ſpace, that contains the one half-inch of air, is little leſs incredible: for that ſpace was ſuppoſed perfectly full of body before, and how a thing can be more than perfectly full, who can conceive? To diſpatch: according to our author's way of condenſation, two, or perhaps two thouſand, bodies may be crouded into a ſpace, that is adequately filled by one of them apart. And if this be not penetration of dimenſions, I deſire to be informed what is ſo; and till then I ſhall leave it to any unprepoſſeſſed Naturaliſt to judge, whether an hypotheſis

that

that needs ſuppoſe a thing ſo generally concluded to be impoſſible to nature, be probable or not; and whether to tell us, that the very ſame parcel of air, that is now without violence contained in half an inch of ſpace, ſhall by and by fill two thouſand times as much room, and preſently after ſhrink again into the two thouſandth part of the ſpace it newly poſſeſſed, be not to turn a body into a ſpirit, and, confounding their notions, attribute to the former the diſcriminating and leaſt eaſily conceivable properties of the latter. And this argument is, I confeſs, with me of that weight, that this alone would keep me from admitting the examiner's hypotheſis: yet if any happier contemplator ſhall prove ſo ſharp-ſighted, as to deviſe and clearly propoſe a way of making the rarefaction and condenſation, hitherto argued againſt intelligible to me, he is not like to find me obſtinate. Nor indeed is there ſufficient cauſe, why his ſucceeding in that attempt ſhould make our adverſaries hypotheſis preferable to ours, ſince that would not prove it either neceſſary, or ſo much as ſufficient, but only anſwer ſome of the arguments, that tend to prove it is not intelligible. And that we have other arguments on our ſide than thoſe that relate to rarefaction and condenſation, may appear partly by what has been diſcourſed already, and partly by what we have now to ſubjoin.

CHAP. IV.

A conſideration (pertinent to the preſent controverſy) of what happens in trying the Torricellian and other experiments, at the tops and feet of hills.

THERE remain then yet a couple of conſiderations to be oppoſed againſt the examiner's hypotheſis, which, though the paſt diſcourſe may make them be looked upon as needleſs, we muſt not pretermit; becauſe they contain ſuch arguments, as may not only be imployed againſt our adverſaries doctrine, but will very much tend to the confirmation of ours.

I CONSIDER then further, that the hypotheſis I am oppoſing, being but a kind of inverſion of ours, and ſuppoſing the ſpring or motion of reſtitution in the air to tend inwards, as according to us it tends outwards; it cannot be, that if the ſuppoſition it ſelf were (what I think I have proved it is not) true, many of the phænomena would be plauſibly enough explicable by it; the ſame motions in an intermediate body being in many caſes producible alike, whether we ſuppoſe it to be thruſt or drawn, provided both the endeavours tend the ſame way. But then we may be ſatisfied, whether the effect be to be aſcribed to pulſion or traction, (as they commonly ſpeak, though indeed the latter ſeems reducible to the former) if we can find out an experiment, wherein there is reaſon ſuch an effect ſhould follow, in caſe pulſion be the cauſe inquired after, and not in caſe it be traction. And ſuch an *experimentum crucis* (to ſpeak with our illuſtrious *Verulam*) is afforded us by that noble obſervation of Monſieur *Paſchal*, mentioned by the famous *Pecquet*, and out of him by our author: Page 66. namely, that the Torricellian experiment being made at the foot and in divers places of a very high mountain, (of the altitude of five hundred fathom or three thouſand foot) he found, that after he had aſcended a hundred and fifty fathom, the quickſilver was fallen two inches and a quarter below its ſtation at the mountain's foot; and that at the very top of the hill it had deſcended above three inches below the ſame wonted ſtation. Whence it appears, that the quickſilver being carried up towards the top of the atmoſphere, falls down the lower, the higher the place is wherein the obſervation is made: of which the reaſon is plain in our hypotheſis, namely, that the nearer we come to the top of the atmoſphere, the ſhorter and lighter is the cylinder of air incumbent upon the reſtagnant mercury; and conſequently the leſs weight of cylindrical mercury will that air be able to counterpoiſe and keep ſuſpended. And ſince this notable phænomenon does thus clearly follow upon ours, and not upon our adverſaries hypotheſis; this experiment ſeems to determine the controverſy betwixt them: becauſe in this caſe the examiner cannot pretend, as he does in the ſeventeenth and divers other of our experiments, that the deſcent of the quickſilver in the tube is cauſed, not by the diminution of the external air's preſſure, but from the preternatural rarefaction or diſtenſion of that external air (in the receiver) when by ſeeking to reſtore it ſelf, it endeavours to draw up the reſtagnant mercury: for in our preſent caſe there appears no ſuch forcible dilatation of that air, as in many of the phænomena of our engine he is pleaſed to imagine.

IT need therefore be no great wonder, if his adverſaries do, as he obſerves, make a great account of this experiment, to prove, that the mercury is kept up in the tube by the reſiſtance of the external air: nor do I think his anſwers to the argument drawn from hence will keep them from thinking it cogent. For to an objection, upon which he takes notice that they lay ſo much ſtreſs, he replies but two things; which neither ſingly nor together will near amount to a ſatisfactory anſwer.

AND, firſt, he queſtions the truth of the obſervation it ſelf; becauſe having made trial in a low hill, the event did no ways anſwer his expectation. But though, inſtead of diſapproving, I am willing to commend his curioſity, to make the experiment himſelf, and eſpecially ſince it was both new and important; and though alſo I like his modeſty, in rather ſuſpecting ſome miſtake in the manner of the obſervation, than that the experimenters did not ſincerely deliver it: yet, ſince there muſt be an error ſomewhere, I muſt rather charge it upon the examiner's obſervation (I ſay, his obſervation, not his want of ſincerity) than upon Monſieur *Paſchal*'s. For beſides the commendations, that the learned *Gaſſendus*, who relates the experiment, gives to that ingenious gentleman (Monſieur *Paſchal*) by whoſe direction he ſuppoſes it to have been tried; the ſame *Gaſſendus* relates, that the like obſervation was five times repeated, *partim intra ſacellum, partim aëre libero, & nunc quidem flante, nunc* Gaſſendus, *Tom* 1, *p.* 211.

ſilente vento: ‘ Sometimes within the chapel, ‘ ſometimes in the open air; the wind ſometimes ‘ blowing, and ſometimes being ſtill.’ Which circumſtances ſufficiently argue the diligence wherewith the experiment was tried in *Auvergne*. Eſpecially ſince I can confirm theſe obſervations by two more made on diſtant hills in *England:* the one of which I procured from that known Virtuoſo Mr. *J. Ball*, whom I deſired to make the experiment at a mountain in *Devonſhire*, on the ſide whereof he dwelt; and the other made in *Lancaſhire* by that ingenious gentleman Mr. *Rich. Townley*. Both which obſervations, ſince I have mentioned them at large in the Appendix to the Phyſico-Mechanical treatiſe, I ſhall not now repeat; contenting my ſelf to obſerve to our preſent purpoſe, that however the proportion of the deſcent of the quickſilver may vary, according to the differing conſiſtence and other accidents of the neighbouring air, in the particular places and times of the experiments being made, yet all obſervations agree in this, that nearer the top of the atmoſphere the quickſilver falls lower than it does further from it. To all this I ſhall add two things, that will very much confirm our hypotheſis. The one is, that the freſhly-named Mr. *Townley*, and divers ingenious perſons that aſſiſted at the trial, bethought themſelves of ſo making the Torricellian experiment at the top of the hill, as to leave a determinate quantity of air in the tube, before the mouth of it was opened under the veſſelled mercury; and taking notice how low ſuch a quantity of that air depreſſed the mercurial cylinder, they likewiſe obſerved, that at the mountain's foot the included air was not able to depreſs the quickſilver ſo much. Whence we infer, that the cylinder of air at the top of the hill being ſhorter and lighter, did not ſo ſtrongly preſs againſt the included air, as did the ambient air at the bottom of the hill, where the aërial cylinder was longer and heavier.

But becauſe that though experiments made in very elevated places are noble ones, and of great importance in the controverſies about the air, yet there are but very few of thoſe, that are qualified to make experiments of that nature, who have the opportunity of making them upon high mountains; we did, with the aſſiſtance of an ingenious man, attempt a trial, wherein we hoped to find a ſenſibly differing weight of the atmoſphere, in a far leſs height than that of an ordinary hill. But inſtead of a common tube, we made uſe of a kind of weather-glaſs, that the included air might help to make the event notable, for a reaſon to be mentioned ere long; and inſtead of quickſilver we employed common water in the pipe belonging to the weather-glaſs, that ſmall changes in the weight or reſiſtance of the atmoſphere in oppoſition of the included air might be the more diſcernable. The inſtrument we made uſe of conſiſted only of a glaſs with a broad foot and a narrow neck A B, and a ſlender glaſs-pipe C D, open at both ends: which pipe was ſo placed, that the bottom of it did almoſt, but not quite, reach to the bottom of the bigger glaſs A B, within whoſe neck A, it was faſtened with a cloſe cement, that both kept the pipe in its place, and hindered all communication betwixt the inward I I and outward K K air, ſave by the cavity of the pipe C D. Now we choſe this glaſs A B more than ordinary capacious, that the effect of the dilatation of the included air I I might be the more conſpicuous. Then conveying a convenient quantity of water H H into this glaſs, we carried it to the leads of the lofty abby-church at *Weſtminſter*, and there blew in a little air to raiſe the water to the upper part of the pipe, that being above the veſſel A B, we might more preciſely mark the ſeveral ſtations of the water than otherwiſe we could. Afterward having ſuffered the glaſs to reſt a pretty while upon the lead, that the air I I within might be reduced to the ſame ſtate, both as to coldneſs and as to preſſure, with K K that without, having marked the ſtation of the water F, we gently let down the veſſel by a long ſtring to the foot of the wall, where one attended to receive it; who having ſuffered it to reſt upon the ground, cried to us, that it was ſubſided about an inch below the mark F we had put. Whereupon having ordered him to put a mark at his ſecond ſtation of it E, we drew up the veſſel again; and ſuffering it to reſt a while, we obſerved the water to be re-aſcended to or near the firſt mark F, which was indeed about an inch above E, the other. And this we did that evening a ſecond time with almoſt a like ſucceſs: though two or three days after, the wind blowing ſtrongly upon the leads, we found not the experiment to ſucceed quite ſo regularly as before; yet the water always manifeſtly fell lower at the foot of the wall than it was at the top: which I ſee no cauſe to aſcribe barely to the differing temperature of the air above and below, as to heat and cold, ſince according to the general eſtimate, the more elevated region of the air is, *cæteris paribus*, colder than that below; which would rather check the greater expanſion of the included air at the top of the leads, than promote it. But the better to avoid miſtakes and prevent objections, we thought fit to try the experiment within the church, and got into a gallery of the ſame height with the leads: but the upper part of the pipe being caſually broken off, we thought fit to order the matter ſo, that the ſurface G of the remaining water in the pipe, ſhould be about an inch higher than the ſurface of the water in the veſſel. And then my above-mentioned correſpondent letting down the glaſs, almoſt as ſoon as it was ſettled upon the pavement, kneeling down to ſee how far it was ſubſided, I found that not only it was fallen as low as the other water, but that the outward air depreſſed it ſo far, as whilſt I was looking on, to break in beneath the bottom of the pipe, and aſcend through the water in bubbles; after which, the glaſs being drawn up again, my correſpondent affirmed, that the water was very manifeſtly re-aſcended. But becauſe by the unlucky breaking of a glaſs, we were hindered to obſerve, as we deſigned, what would happen as well in a weather-glaſs, ſo con-

contrived, that the weight or preſſure of the atmoſphere ſhould make no change in it, as in another whoſe included air was at the top, (whereas, in that we employed, the included air was in the lower part,) and becauſe there happened in our trials a circumſtance or two that ſeemed not ſo devoid of difficulties, but that we think it may require further examination, we deſign to ſet down a more particular account of this experiment, (as how it ſucceeds with quickſilver inſtead of water, together with the capacity of the veſſel A B and the bore of the pipe C D, with ſome other variety of circumſtances) together with the event of the curioſity we had (which ſeemed very ſucceſsful) to try the Torricellian experiment upon the above-mentioned leads; and then let down the tube, together with the reſtagnant mercury, to the ground, to obſerve the increaſing altitude of the quickſilver, in the formerly-mentioned appendix to the epiſtle we have been defending. And it ſhall ſuffice us, in the mean time, that the trials already mentioned ſeem to make it evident enough, that the atmoſphere gravitates more, *cæteris paribus*, near the ſurface of the earth, than in the more elevated parts of the air. For the leads, on which we made our trials, were found by meaſure to be in perpendicular height but threeſcore and fifteen foot from the ground. To which we ſhall only add this at preſent, that once being deſirous to obſerve what we could touching the proportions of the ſubſidence of the water to the height of its ſeveral ſtations from the ground, purpoſely carrying down the veſſel ſo as not conſiderably to heat it, from the leads down the ſtairs to a little window that we gueſs to be almoſt half way to the bottom, we there perceived the water to have already ſubſided about a barley-corn's length; notwithſtanding that probably, in ſpite of our care, the veſſel were a little warmed by the heat of his body that carried it, ſince by that time we were come to the foot of the wall, the water ſtood almoſt at the higheſt mark; but after the veſſel was ſuffered to reſt a while, it relapſed by degrees to the loweſt. And thus much for the firſt of the things I had to repreſent in favour of our doctrine.

THE other particular I ſhall mention for confirmation of our hypotheſis, is that experiment (which, though it be needleſs, ſeems yet more cogent and proper to prevent evaſions) made by the ſame Monſieur *Paſchal*, of carrying a weakly-blown foot-ball from the bottom to the top of an high mountain. For that foot-ball ſwelled more and more, the higher it was carried, ſo that it appeared as if it were full blown at the top of the mountain, and gradually growing lank again, as it was carried downwards; ſo that at the foot of the hill it was flaccid as before. This, I ſay, having thus happened, we have here an experiment to prove our hypotheſis, wherein recourſe cannot be had to any forcibly and preternaturally diſtended body, ſuch as that is pretended to be, which remains in the deſerted ſpace of the tube in the Torricellian experiment.

THE other thing, which the examiner alledges againſt our argument from Monſieur *Paſchal*'s trials, is, that ſuppoſing it to be true, yet it cannot thence be inferred, that the ſubſidence of the mercury at the top of the hill proceeded from the atmoſpherical cylinder's being there lighter and leſs able to ſuſtain the quickſilver. *Sed dici poteſt* (ſays he) *ideo ſic* *Page* 63. *in vertice montis magis deſcendiſſe, quod ibidem eſſet aura frigidior, aut ex alio temperamento hujuſmodi deſcenſum cauſante.* 'But it may be 'ſaid, that on the top of the mountain it there-'fore deſcended after that manner, becauſe the 'air was more cold there, or of ſome other 'temperature, ſuch as might cauſe this deſcent.' But this ſolution will not ſerve the turn: for the coldneſs of the ambient air (which yet the experiments take not notice of) would rather contract the rarefied ſubſtance within the tube, and ſo draw up the mercury higher; as our author himſelf teaches us, that it is from the ſhrinking of the Funiculus, occaſioned by the cold, that the water in thermometers aſcends in cold weather. And whereas the only proof he adds of ſo improbable an explication is taken *Page* 50. from our eighteenth experiment, wherein we relate, that ſometimes the quickſilver did ſenſibly fall lower in colder than in far leſs cold weather; I anſwer, that this eighteenth experiment will ſcarce make more for him than againſt him: for, as I there take notice, that the quickſilver deſcended in cold weather, ſo it ſometimes deſcended likewiſe in hot weather, and roſe in cold. And it is very ſtrange, that in all the obſervations made in differing countries and at differing times, it ſhould ſtill ſo happen, that the mercurial cylinder ſhould be ſhorter near the top of the atmoſphere than further from it; if the reſiſtance of the outward air have nothing to do with the keeping it ſuſpended. And it is yet more ſtrange, that the foot-ball ſhould in like manner grow turgid and flaccid, according as it is carried into places where it has a ſhorter or longer pillar of air incumbent on it.

I WAS going to proceed to what remains of this ſecond part of our treatiſe, but that, ſince I begun this chapter, caſually meeting with an experiment lately ſent in a letter to a very ingenious * acquaintance of his and mine, by a very induſtrious † phyſician (who is ſaid to have had the curioſity to try over again many of the experiments of our engine) and finding it very proper to confirm our newly related experiment made at *Weſtminſter*, and to be of ſuch a nature as we have not in this part of *England* the opportunity to try the like, for want of hills high enough; I ſhall (according to the permiſſion given me) inſert it in this place. And the rather, that as the mountains have, by the trials made on them of the Torricellian experiment, afforded us a noble proof of the weight of the air; ſo they may afford us one of its ſpring: wherein I hope the phænomenon of the water's deſcent will not be aſcribed to any attraction made of the water by the violently-diſtended outward air. And becauſe the experiment was not made by us, but by another, we will ſet it down in his words, which are theſe: *This fifteenth of* October 1661, *we took a weather-glaſs* A B, *of about two foot in length, and carrying it to the bottom of* Hallifax *hill,* *See the ſecond figure.*

* *Mr.* Croon, *one of the learned profeſſors of* Gresham *college.*

† *Dr.* Hen. Power.

hill, the water ſtood in the ſhank at thirteen inches above the water in the veſſel: thence carrying it thus filled, with the whole frame, immediately to the top of the ſaid hill, the water fell down to the point D, viz. *an inch and a quarter lower than it was at the bottom of the ſaid hill*; *which* (as he rightly infers) *proves the elaſticity of the air. For the internal air* A C, *which was of the ſame power and extenſion with the external at the bottom of the hill, did manifeſt a greater elaſticity than the mountain-air there* *, *and ſo extended itſelf further by* C D.

THE like experiment, I hear, the ſame ingenious doctor has very lately repeated, and found the deſcent of the water to be greater than before. And though ſome Virtuoſi have thought it ſtrange, that in an hill far inferiour to the *Alps* and *Apennines*, ſo ſhort a cylinder of ſo light a liquor as water ſhould fall ſo much; yet I ſee not any reaſon to diſtruſt upon this ground either his experiment or ours (lately mentioned to have been made at *Weſtminſter*;) but rather to wonder the water fell no more, (if the hill be conſiderably high.) For their ſuſpicion ſeems grounded upon a miſtake, as if becauſe the quickſilver in the Torricellian experiment, made without purpoſely leaving any air in the tube, would not, at the top of the mentioned hill, have ſubſided above an inch, if ſo much; the water, that is near fourteen times lighter, ſhould not fall above a fourteenth part of that ſpace: whereas in the Torricellian experiment, the upper and deſerted ſpace of the tube has little or no air left in it, but the correſpondent part of the water-glaſs was furniſhed with air, whoſe preſſure was little leſs than that of the atmoſphere at the bottom of the hill; and conſequently muſt be much greater than the preſſure of the atmoſphere at the top of the hill, where the atmoſpherical cylinder's gravity (upon whoſe account it preſſes) muſt be much diminiſhed by its being made much ſhorter, and by its conſiſting of an air leſs compreſt. And thus much for the firſt of the two conſiderations wherewith I promiſed to conclude this ſecond part of the preſent tract. Only before I proceed, I muſt in a word deſire the reader to take notice, that though I have here ſingled out but one of the nine experiments which the examiner in the 11th and 12th chapters reckons up as urged by his adverſaries; yet do not thereby declare my acquieſcing in his explications of thoſe phænomena, but only leave both them and ſome other things he delivers about ſiphons and the *Magdeburg* experiments, to be diſcourſed by thoſe, that are more concerned to examine them, contenting my ſelf to have ſufficiently diſproved the Funiculus which his expoſitions ſuppoſe, and cleared the grounds of explicating ſuch experiments aright.

CHAP. V.

Two new Experiments touching the meaſure of the force of the ſpring of air compreſſed and dilated.

THE other thing, that I would have conſidered touching our adverſary's hypotheſis is, that it is needleſs. For whereas he denies not, that the air has ſome weight and ſpring, but affirms, that it is very inſufficient to *Page* 11. perform ſuch great matters as the counterpoiſing of a mercurial cylinder of 29 inches, as we teach that it may; we ſhall now endeavour to manifeſt by experiments purpoſely made, that the ſpring of the air is capable of doing far more than it is neceſſary for us to aſcribe to it, to ſolve the phænomena of the Torricellian experiment.

WE took then a long glaſs-tube, which by a dexterous hand and the help of a lamp was in ſuch a manner crooked at the bottom, that the part turned up was almoſt parallel to the reſt of the tube, and the orifice of this ſhorter leg of the ſiphon (if I may ſo call the whole inſtrument) being hermetically ſealed, the length of it was divided into inches, (each of which was ſubdivided into eight parts) by a ſtreight liſt of paper, which containing thoſe diviſions, was carefully paſted all along it. Then putting in as much quickſilver as ſerved to fill the arch or bended part of the ſiphon, that the mercury ſtanding in a level might reach in the one leg to the bottom of the divided paper, and juſt to the ſame height or horizontal line in the other; we took care, by frequently inclining the tube, ſo that the air might freely paſs from one leg into the other by the ſides of the mercury, (we took, I ſay, care) that the air at laſt included in the ſhorter cylinder ſhould be of the ſame laxity with the reſt of the air about it. This done, we began to pour quickſilver into the longer leg of the ſiphon, which by its weight preſſing up that in the ſhorter leg, did by degrees ſtreighten the included air: and continuing this pouring in of quickſilver till the air in the ſhorter leg was by condenſation reduced to take up but half the ſpace it poſſeſſed (I ſay, poſſeſſed, not filled) before; we caſt our eyes upon the longer leg of the glaſs, on which was likewiſe paſted a liſt of paper carefully divided into inches and parts, and we obſerved, not without delight and ſatisfaction, that the quickſilver in that longer part of the tube was 29 inches higher than the other. Now that this obſervation does both very well agree with and confirm our hypotheſis, will be eaſily diſcerned by him, that takes notice what we teach; and Monſieur *Paſchal* and our Engliſh friend's experiments prove, that the greater the weight is that leans upon the air, the more forcible is its endeavour of dilatation, and conſequently its power of reſiſtance, (as other ſprings are ſtronger when bent by greater weights.) For this being conſidered, it will appear to agree rarely-well with the hypotheſis, that as according to it the air in that degree of denſity and correſpondent meaſure of reſiſtance, to which the weight of the incumbent atmoſphere had brought it, was able to counterbalance and reſiſt the preſſure of a mercurial cylinder of about 29 inches, as we are taught by the Torricellian experiment; ſo here the ſame air being brought to a degree of denſity about twice as great as that it had before, obtains a ſpring twice as ſtrong as formerly. As may appear by its being able to ſuſtain or reſiſt a cylinder of 29 inches in the longer

* Probably theſe or the like words, *did manifeſt preſſure*, are here omitted, for the mountain-air there ſeems to have acted rather by its weight than elaſticity.

longer tube, together with the weight of the atmoſpherical cylinder, that leaned upon thoſe 29 inches of mercury; and, as we juſt now inferred from the Torricellian experiment, was equivalent to them.

WE were hindered from proſecuting the trial at that time by the caſual breaking of the tube. But becauſe an accurate experiment of this nature would be of great importance to the doctrine of the ſpring of the air, and has not yet been made (that I know) by any man; and becauſe alſo it is more uneaſy to be made than one would think, in regard of the difficulty as well of procuring crooked tubes fit for the purpoſe, as of making a juſt eſtimate of the true place of the protuberant mercury's ſurface; I ſuppoſe it will not be unwelcome to the reader, to be informed, that after ſome other trials, one of which we made in a tube whoſe longer leg was perpendicular, and the other, that contained the air, parallel to the horizon, we at laſt procured a tube of the figure expreſt in *See* Fig. 5. the ſcheme; which tube, though of a pretty bigneſs, was ſo long, that the cylinder, whereof the ſhorter leg of it conſiſted, admitted a liſt of paper, which had before been divided into 12 inches and their quarters, and the longer leg admitted another liſt of paper of divers feet in length, and divided after the ſame manner. Then quickſilver being poured in to fill up the bended part of the glaſs, that the ſurface of it in either leg might reſt in the ſame horizontal line, as we lately taught, there was more and more quickſilver poured into the longer tube; and notice being watchfully taken how far the mercury was riſen in that longer tube, when it appeared to have aſcended to any of the diviſions in the ſhorter tube, the ſeveral obſervations, that were thus ſucceſſively made, and as they were made ſet down, afforded us the enſuing table.

A table of the condenſation of the air.

A	*A*	*B*	*C*	*D*	*E*
48	12	00		29 2/16	29 2/16
46	11 1/2	01 7/16		30 9/16	33 6/16
44	11	02 13/16		31 15/16	31 12/16
42	10 1/2	04 6/16		33 8/16	33 1/7
40	10	06 3/16		35 5/16	35 - -
38	9 1/2	07 14/16		37 - -	36 15/19
36	9	10 2/16		39 5/16	38 7/8
34	8 1/2	12 8/16		41 10/16	41 2/17
32	8	15 1/16	Added to 22 1/8 makes	44 3/16	43 11/16
30	7 1/2	17 15/16		47 1/16	46 3/5
28	7	21 3/16		50 5/16	50 - -
26	6 1/2	25 3/16		54 5/16	53 10/13
24	6	29 11/16		58 13/16	58 2/8
23	5 3/4	32 3/16		61 5/16	60 18/23
22	5 1/2	34 15/16		64 1/16	63 6/11
21	5 1/4	37 15/16		67 1/16	66 4/7
20	5	41 9/16		70 11/16	70 - -
19	4 3/4	45 - -		74 2/16	73 11/19
18	4 1/2	48 12/16		77 14/16	77 2/3
17	4 1/4	53 11/16		82 12/16	82 4/17
16	4	58 2/16		87 14/16	87 3/8
15	3 3/4	63 15/16		93 1/16	93 1/5
14	3 1/2	71 5/16		100 7/16	99 6/7
13	3 1/4	78 11/16		107 13/16	107 7/13
12	3	88 7/16		117 9/16	116 4/8

AA. The number of equal ſpaces in the ſhorter leg, that contained the ſame parcel of air diverſly extended.

B. The height of the mercurial cylinder in the longer leg, that compreſſed the air into thoſe dimenſions.

C. The height of a mercurial cylinder that counterbalanced the preſſure of the atmoſphere.

D. The aggregate of the two laſt columns *B* and *C*, exhibiting the preſſure ſuſtained by the included air.

E. What that preſſure ſhould be according to the hypotheſis, that ſuppoſes the preſſures and expanſions to be in reciprocal proportion.

FOR the better underſtanding of this experiment, it may not be amiſs to take notice of the following particulars:

1. THAT the tube being ſo tall, that we could not conveniently make uſe of it in a chamber, we were fain to uſe it on a pair of ſtairs, which yet were very lightſome, the tube being for preſervation's ſake by ſtrings ſo ſuſpended, that it did ſcarce touch the box preſently to be mentioned.

2. THE lower and crooked part of the pipe was placed in a ſquare wooden box, of a good largeneſs and depth, to prevent the loſs of the quickſilver, that might fall aſide in the transfuſion from the veſſel into the pipe, and to receive the whole quickſilver in caſe the tube ſhould break.

3. THAT we were two to make the obſervation together, the one to take notice at the bottom, how the quickſilver roſe in the ſhorter cylinder, and the other to pour in at the top of the longer; it being very hard and troubleſome for one man alone to do both accurately.

4. THAT the quickſilver was poured in but by little and little, according to the direction of him that obſerved below; it being far eaſier to pour in more, than to take out any, in caſe too much at once had been poured in.

5. THAT at the beginning of the operation, that we might the more truly diſcern where the quickſilver reſted from time to time, we made uſe of a ſmall looking-glaſs, held in a convenient poſture to reflect to the eye what we deſired to diſcern.

6. THAT when the air was ſo compreſſed, as to be crouded into leſs than a quarter of the ſpace it poſſeſſed before, we tried whether the cold of a linen cloth dipped in water would then condenſe it. And it ſometimes ſeemed a little to ſhrink, but not ſo manifeſtly as that we dare build any thing upon it. We then tried likewiſe, whether heat would, notwithſtanding ſo forcible a compreſſure, dilate it; and approaching the flame of a candle to that part where the air was pent up, the heat had a more ſenſible operation than the cold had before: ſo that we ſcarce doubted, but that the expanſion of the air would, notwithſtanding the weight that oppreſt it, have been made conſpicuous, if the fear of unſeaſonably breaking the glaſs had not kept us from increaſing the heat.

Now although we deny not, but that in our table ſome particulars do not ſo exactly anſwer to what our formerly mentioned hypotheſis might perchance invite the reader to expect; yet the variations are not ſo conſiderable, but that they may probably enough be aſcribed to ſome ſuch want of exactneſs as in ſuch nice experiments is ſcarce avoidable. But for all that, till further trial hath more clearly informed me, I ſhall not venture to determine, whether or no

the intimated theory will hold univerſally and preciſely, either in condenſation of air, or rarefaction: all that I ſhall now urge being, that however the trial already made ſufficiently proves the main thing, for which I here alledge it; ſince by it, it is evident, that as common air, when reduced to half its wonted extent, obtained near about twice as forcible a ſpring as it had before; ſo this thus compreſt air being further thruſt into half this narrow room, obtained thereby a ſpring about as ſtrong again as that it laſt had, and conſequently four times as ſtrong as that of the common air. And there is no cauſe to doubt, that if we had been here furniſhed with a greater quantity of quick-ſilver and a very ſtrong tube, we might, by a further compreſſion of the included air, have made it counterbalance the preſſure of a far taller and heavier cylinder of mercury. For no man perhaps yet knows, how near to an infinite compreſſion the air may be capable of, if the compreſſing force be competently increaſed. So thathere our adverſary may plainly ſee, that the ſpring of the air, which he makes ſo light of, may not only be able to reſiſt the weight of 29 inches, but in ſome caſes of above a hundred inches of quickſilver, and that without the aſſiſtance of his Funiculus, which in our preſent caſe has nothing to do. And to let you ſee, that we did not (as a little above) inconſiderately mention the weight of the incumbent atmoſpherical cylinder as a part of the weight reſiſted by the impriſoned air, we will here annex, that we took care, when the mercurial cylinder in the longer leg of the pipe was about an hundred inches high, to cauſe one to ſuck at the open orifice; whereupon (as we expected) the mercury in the tube did notably aſcend. Which conſiderable phænomenon cannot be aſcribed to our examiner's Funiculus, ſince by his own confeſſion that cannot pull up the mercury, if the mercurial cylinder be above 29 or 30 inches of mercury. And therefore we ſhall render this reaſon of it, that the preſſure of the incumbent air being in part taken off by its expanding it ſelf into the ſucker's dilated cheſt; the impriſoned air was thereby enabled to dilate itſelf manifeſtly, and repel the mercury, that compreſt it, till there was an equality of force betwixt the ſtrong ſpring of that compreſt air on the one part, and the tall mercurial cylinder, together with the contiguous dilated air, on the other part.

Now, if to what we have thus delivered concerning the compreſſion of air, we add ſome obſervations concerning its ſpontaneous expanſion, it will the better appear, how much the phænomena of theſe mercurial experiments depend upon the differing meaſures of ſtrength to be met with in the air's ſpring, according to its various degrees of compreſſion and laxity. But, before I enter upon this ſubject, I ſhall readily acknowledge, that I had not reduced the trials I had made about meaſuring the expanſion of the air to any certain hypotheſis, when that ingenious gentleman Mr. *Richard Townley* was pleaſed to inform me, that having by the peruſal of my phyſico-mechanical experiments been ſatisfied, that the ſpring of the air was the cauſe of it, he had endeavoured, (and I wiſh in ſuch attempts other ingenious men would follow his example) to ſupply what I had omitted concerning the reducing to a preciſe eſtimate, how much air dilated of itſelf loſes of its elaſtical force, according to the meaſures of its dilatation. He added, that he had begun to ſet down what occurred to him to this purpoſe in a ſhort diſcourſe, whereof he afterwards did me the favour to ſhew me the beginning, which gives me a juſt curioſity to ſee it perfected. But, becauſe I neither know, nor (by reaſon of the great diſtance betwixt our places of reſidence) have at preſent the opportunity to inquire, whether he will think fit to annex his diſcourſe to our appendix, or to publiſh it by itſelf, or at all; and becauſe he hath not yet, for aught I know, met with fit glaſſes to make an anything-accurate table of the decrement of the force of the dilated air; our preſent deſign invites us to preſent the reader with that which follows, wherein I had the aſſiſtance of the ſame perſon, that I took notice of in the former chapter, as having written ſomething about rarefaction: whom I the rather make mention of on this occaſion, becauſe when he firſt heard me ſpeak of Mr. *Townley*'s ſuppoſitions about the proportion, wherein air loſes of its ſpring by dilatation, he told me he had the year before (and not long after the publication of my pneumatical treatiſe) made obſervations to the ſame purpoſe, which he acknowledged to agree well enough with Mr. *Townley*'s theory: And ſo did (as their author was pleaſed to tell me) ſome trials made about the ſame time by that noble virtuoſo and eminent mathematician the Lord *Brouncker*, from whoſe further enquiries into this matter, if his occaſions will allow him to make them, the curious may well hope for ſomething very accurate.

A table of the rarefaction of the air.

	A	*B*	*C*	*D*	*E*
A. The number of equal ſpaces at the top of the tube, that contained the ſame parcel of air.	1	00 0/0	Subtracted from 29 3/4 leaves:	29 3/4	29 5/4
	1 1/2	10 9/12		19 1/8	19 5/6
	2	15 3/8		14 7/8	14 7/8
	3	20 2/8		9 4/6	9 1 5/12
	4	22 5/8		7 1/8	7 7/16
B. The height of the mercurial cylinder, that together with the ſpring of the included air counterbalanced the preſſure of the atmoſphere.	5	24 1/8		5 5/8	5 1 9/16
	6	24 7/8		4 7/8	4 2 7/16
	7	25 4/8		4 2/8	4 1/4
	8	26 0/0		3 0/8	3 2 3/32
	9	26 3/8		3 3/8	3 1 1/8 16
	10	26 6/8		3 0/0	2 3 9/16
	12	27 1/8		2 5/8	2 2 3/8
C. The preſſure of the atmoſphere.	14	27 4/8		2 2/8	2 1/8
	16	27 6/8		2 0/0	1 15/16 4
D. The complement of *B* to *C*, exhibiting the preſſure ſuſtained by the included air.	18	27 7/8		1 7/8	1 4 7/12
	20	28 0/0		1 6/8	1 9/8 16
	24	28 2/8		1 4/8	1 2 3/9 16
	28	28 3/8		1 3/8	1 1/1 16
	32	28 4/8		1 2/8	0 1 1 9/12 8

E. What that preſſure ſhould be, according to the hypotheſis.

To make the experiment of the debilitated force of expanded air the plainer, it will not be amiſs to note ſome particulars, eſpecially touching the manner of making the trial; which

which (for the reaſons lately mentioned) we made on a lightſome pair of ſtairs, and with a box alſo lined with paper to receive the mercury that might be ſpilt. And in regard it would require a vaſt, and in few places procurable quantity of quickſilver, to imploy veſſels of ſuch kind as are ordinary in the Torricellian experiment, we made uſe of a glaſs-tube of about ſix foot long; for that being hermetically ſealed at one end, ſerved our turn as well as if we could have made the experiment in a tub or pond of ſeventy inches deep.

SECONDLY, We alſo provided a ſlender glaſs-pipe of about the bigneſs of a ſwan's-quill, and open at both ends; all along which was paſted a narrow liſt of paper, divided into inches and half quarters.

THIRDLY, This ſlender pipe being thruſt down into the greater tube almoſt filled with quickſilver, the glaſs helped to make it ſwell to the top of the tube; and the quickſilver getting in at the lower orifice of the pipe, filled it up till the mercury included in that was near about a level with the ſurface of the ſurrounding mercury in the tube.

FOURTHLY, There being, as near as we could gueſs, little more than an inch of the ſlender pipe left above the ſurface of the reſtagnant mercury, and conſequently unfilled therewith, the prominent orifice was carefully cloſed with ſealing-wax melted; after which the pipe was let alone for a while, that the air dilated a little by the heat of the wax, might, upon refrigeration, be reduced to its wonted denſity. And then we obſerved by the help of the above-mentioned liſt of paper, whether we had not included ſomewhat more or ſomewhat leſs than an inch of air; and in either caſe we were fain to rectify the error by a ſmall hole made (with a heated pin) in the wax, and afterwards cloſed up again.

FIFTHLY, Having thus included a juſt inch of air, we lifted up the ſlender pipe by degrees, till the air was dilated to an inch, an inch and an half, two inches, *&c.* and obſerved in inches and eighths the length of the mercurial cylinder, which at each degree of the air's expanſion was impelled above the ſurface of the reſtagnant mercury in the tube.

SIXTHLY, The obſervations being ended, we preſently made the Torricellian experiment with the above-mentioned great tube of ſix feet long, that we might know the height of the mercurial cylinder, for that particular day and hour; which height we found to be 29 $\frac{3}{4}$ inches.

SEVENTHLY, Our obſervations made after this manner furniſhed us with the preceding table, in which there would not probably have been found the difference here ſet down betwixt the force of the air, when expanded to double its former dimenſions, and what that force ſhould have been preciſely according to the theory, but that the included inch of air received ſome little acceſſion during the trial; which this newly-mentioned difference making us ſuſpect, we found by replunging the pipe into the quickſilver, that the included air had gained about half an eighth, which we gueſſed to have come from ſome little aërial bubbles in the quickſilver, contained in the pipe (ſo eaſy is it in ſuch nice experiments to miſs of exactneſs.) We tried alſo with 12 inches of air ſhut up to be dilated; but being then hindered by ſome unwelcome avocations to proſecute thoſe experiments, we ſhall elſewhere, out of other notes and trials (God permitting) ſet down ſome other accurate tables concerning this matter. By which poſſibly we may be aſſiſted to reſolve, whether the atmoſphere ſhould be looked upon (as it uſually is) as a limited and bounded portion of the air; or whether we ſhould in a ſtricter ſenſe than we did before, uſe the atmoſphere and aërial part of the world for almoſt equivalent terms; or elſe whether we ſhould allow the word atmoſphere ſome other notion in relation to its extent and limits; (for as to its ſpring and weight, theſe experiments do not queſtion, but evince them.) But we are willing, as we ſaid, to refer theſe matters to our Appendix, and till then to retain our wonted manner of ſpeaking of the air and atmoſphere. In the mean time (to return to our laſt-mentioned experiments) beſides that ſo little a variation may be in great part imputed to the difficulty of making experiments of this nature exactly, and perhaps a good part of it to ſomething of inequality in the cavity of the pipe, or even in the thickneſs of the glaſs; beſides this, I ſay, the proportion betwixt the ſeveral preſſures of the included air undilated and expanded, eſpecially when the dilatation was great (for when the air ſwelled but to four times its firſt extent, the mercurial cylinder, though of near 23 inches, differed not a quarter of an inch from what it ſhould have been according to mathematical exactneſs) the proportion, I ſay, was ſuitable enough to what might be expected, to allow us to make this reflection upon the whole; that whether or no the intimated theory will hold exactly, (for about that, as I ſaid above, I dare determine nothing reſolutely till I have further conſidered the matter) yet ſince the inch of air, when it was firſt included, was ſhut up with no other preſſure than that, which it had from the weight of the incumbent air, and was no more compreſſed than the reſt of the air we breathed and moved in; and ſince alſo this inch of air, when expanded to twice its former dimenſions, was able with the help of a mercurial cylinder of about 15 inches to counterpoiſe the weight of the atmoſphere, which the weight of the external air gravitating upon the reſtagnant mercury was able to impel up into the pipe, and ſuſtain above twenty eight inches of mercury, when the internal air, by its great expanſion, had its ſpring too far debilitated to make any conſiderable (I ſay conſiderable, for it was not yet ſo dilated as not to make ſome) reſiſtance: ſince, I ſay, theſe things are ſo, the free air here below appears to be almoſt as ſtrongly compreſſed by the weight of the incumbent air, as it would be by the weight of a mercurial cylinder of twenty eight or thirty inches; and conſequently is not in ſuch a ſtate of laxity and freedom as men are wont to imagine; and acts

like ſome mechanical agent, the decrement of whoſe force holds a ſtricter proportion to its increaſe of dimenſion, than has been hitherto taken notice of.

I Must not now ſtand to propoſe the ſeveral reflections, that may be made upon the foregoing obſervations touching the compreſſion and expanſion of air; partly becauſe we could ſcarce avoid making the hiſtorical part ſomewhat prolix; and partly becauſe I ſuppoſe we have already ſaid enough to ſhew what was intended; namely, that to ſolve the phænomena there is not of our adverſary's hypotheſis any need: the evincing of which will appear to be of no ſmall moment in our preſent controverſy to him, that conſiders, that the two main things, that induced the learned examiner to reject our hypotheſis, are, that nature abhors a vacuum; and that though the air have ſome weight and ſpring, yet, theſe are inſufficient to make out the known phænomena; for which we muſt therefore have recourſe to his Funiculus. Now as we have formerly ſeen, that he has not ſo ſatisfactorily diſproved as reſolutely rejected a vacuum, ſo we have now manifeſted, that the ſpring of the air may ſuffice to perform greater things than what our explication of the Torricellian experiments and thoſe of our engine obliges us to aſcribe to it. Wherefore ſince beſides the ſeveral difficulties, that incumber the hypotheſis we oppoſe, and eſpecially its being ſcarce, if at all, intelligible, we can add that it is unneceſſary; we dare expect, that ſuch readers as are not biaſſed by their reverence for *Ariſtotle*, or the Peripatetick ſchools, will hardly reject an hypotheſis, which, beſides that it is very intelligible, is now proved to be ſufficient, only to imbrace a doctrine, that ſuppoſes ſuch a rarefaction and condenſation, as many famous Naturaliſts rejected for its not being comprehenſible, even when they knew of no other way (that was probable) of ſolving the phænomena wont to be explicated by it.

PART III.

Wherein what is objected againſt Mr. Boyle's *Explications of particular Experiments, is anſwered.*

AND now we are come to the third and laſt part of our defence; wherein we are to conſider, what our examiner is pleaſed to object againſt ſome paſſages of our Phyſico-Mechanical Treatiſe. But though this may ſeem the only part, wherein I am particularly concerned; yet perhaps we ſhall find it, if not the ſhorteſt, at leaſt the eaſieſt, part of our taſk. Partly, becauſe our author takes no exceptions at the experiments themſelves, as we have recorded them, (which from an adverſary, who in ſome places ſpeaks of them as an eye-witneſs, is no contemptible teſtimony, that the matters of fact have been rightly delivered:) and partly, becauſe there are divers experiments which, together with their explications, the examiner has thought fit to leave untouched, and thereby allows us to do ſo too: and partly alſo, becauſe that (as to divers of thoſe experiments, upon which he animadverts) he does not pretend to ſhew, that our explications are ill deduced or incongruous to our principles; but only that the phænomena may be explained either better, or as well, by his hypotheſis; whereof he ſuppoſes himſelf to have demonſtrated the truth, together with the erroneouſneſs of ours, in the other parts of his book, eſpecially the third, fourth and fifth chapters. So that after what we have ſaid to vindicate the hypotheſis we maintain, and take away our author's imaginary Funiculus; it will not be requiſite for us, on ſuch occaſions, to examine his particular aſſertions and explications. Which advertiſement we hope the reader will be pleaſed to bear in mind, and thereby ſave himſelf and us the trouble of a great deal of unneceſſary repetition. Wherefore preſuming he will do ſo, we ſhall not ſtay to examine the firſt and ſecond corollaries, which in his 17th chapter he annexes to the manner of emptying our receiver by our pump. Neither ſhould we ſay any thing as to his third and laſt corollary, but that we think fit to deſire the reader to take notice, that according to what he teaches in that place, the more the air is rarefied, the more forcibly it is able to contract it ſelf.

A defence of our firſt and ſecond Experiments.

AND to proceed now to his 18th chapter, which he intitles *De experimentis Boylianis*, we ſhall find, according to what we lately noted, that againſt the firſt experiment he objects nothing, ſave that if one of the fingers be applied to the orifice of the valve, when the pump is freed from air, the experimenter ſhall feel to his pain, that the ſucker is not thruſt inward by the external air, but, as the finger, drawn inward by the internal. But this phænomenon of the intruſion of the finger into a cavity, where it finds no reſiſtance, having been formerly accounted for according to our hypotheſis, we ſhall not need to repeat our explication of it; though this miſtaken phænomenon ſupplies our adverſary with divers of his following animadverſions, and indeed with a great part of his book. And accordingly his objection againſt our ſecond experiment being of the ſame nature with that againſt the firſt, requires but the ſame anſwer: for it will not alter the caſe, that he adds upon this experiment, *hoc eſſe diſcrimen manifeſtum inter preſſionem & ſuctionem, quod ſuctio efficiat hujuſmodi adhæſionem, preſſio autem minimè:*

'That

'That this is the difference between preſſion 'and ſuction, that ſuction makes ſuch an ad- 'heſion, and preſſion doth not:' Since to ſay ſo, is but to affirm, not to prove.

EXPERIMENT III.

WHAT our author would except againſt the 3d. experiment he ought to have more intelligibly expreſſed: for whereas of a diſcourſe, wherein I deliver ſeveral particulars, he only ſays, that *nullatenus ſatisfacit, ut legenti conſtabit*; I would not do the reader the injury to ſuſpect him of taking this proof-leſs aſſertion for a rational confutation: eſpecially ſince upon the review of that third experiment, I find nothing, that agrees not with my hypotheſis, however it may diſagree with the examiner's. But, to conſider the explication he ſubſtitutes in the room of our doctrine, which he rejects, he gives it us in theſe words: *Hoc quoque experimentum principiis noſtris optime convenit: cum enim per illam emboli depreſſionem aër in cavitate brachii incluſus ſeparetur ab eodem brachio, deſcendatque ſimul cum embolo (uti de aqua ſimul cum argento vivo deſcendente capite decimo tertio vidimus) fit ut in tota illa depreſſione, novæ ſemper ab aëre illo deſcendente ſuperficies diripiantur ſimul & extendantur, ut ibidem de aqua eſt explicatum: cum itaque æque facile diripiantur & extendantur hujuſmodi ſuperficies in fine depreſſionis ac initio, mirum non eſt, quod eadem utrobique ſentiatur deprimendi difficultas:* 'And even this experiment doth very well 'agree with our principles: for ſeeing by this 'depreſſion of the ſucker, the air ſhut up in 'the cavity of the cylinder is ſeparated from 'the cylinder, and doth deſcend together with 'the ſucker, (as we have, chap. 13. obſerved 'of water deſcending together with quick- 'ſilver) it comes to paſs, that in that whole 'depreſſion new ſurfaces are taken from that 'deſcending air, and ſtretched out, as we have 'there explained it in the caſe of deſcending 'water. Since therefore ſuch ſurfaces are as 'eaſily ſlipped off and extended in the end of 'the depreſſion as in the beginning; it is no 'wonder, that there is found the ſame difficulty 'of depreſſing it at both times.'

By which though he ſeems to intend an oppoſition to that part of the third experiment, which I oppoſed not againſt his opinion, but that of ſome learned vacuiſts; yet (not to mention, that he ſeems to have ſomewhat miſtaken my ſenſe) he offers nothing at all to invalidate my inference againſt them; but, inſtead of that, propoſes a defence of his own opinion, which ſuppoſes the truth of his diſproved hypotheſis, and is either unſatisfactory even according to that, or elſe diſagrees with what himſelf hath taught us but a little before. For it is evident, that the more the ſucker is depreſſed, the more the cylinder is exhauſted of air. And in his third corollary (which we lately deſired the reader to obſerve) ſpeaking of the air in the receiver (and the caſe is the ſame with the air in the cylinder) he affirms more than once, *Eo magis extendi ac rarefieri aërem relictum, quo plus inde exhauritur, majoremque proinde acquirere vim ſeſe contrahendi:* 'That the air is ſo much the more extended 'and rarefied, by how much the more is 'thence exhauſted, and ſo doth acquire a great- 'er force of contracting it ſelf.' Whereas here he would have us believe, that the little internal air, that was in the cavity of the ſhank of the ſtop-cock, does as ſtrongly retract the ſucker, or, which in our caſe is all one, reſiſt its depreſſion, when the ſucker is yet near the top of the cylinder, (and conſequently when the included air is but a little dilated) as when the ſame ſucker being forced down to the lower part of the cylinder, the ſame portion of remaining air muſt be exceedingly more diſtended.

EXPERIMENT IV.

IN the fourth experiment, touching the ſwelling of a bladder upon the removal of the ambient air, and proportionably to that removal, our author objects nothing againſt the explication we give of it by the ſpring of the air included in the bladder, and diſtending it according as the preſſure of the ambient air is weakened. But he endeavours alſo to explicate it his way, to which he ſays this circumſtance does excellently agree, that upon the regreſs of the external air into the receiver, the tumid bladder immediately ſhrinks, becauſe (ſaith he) by ſuch ingreſs of the external air, the air in the receiver, which drew the ſides of the bladder outward from the middle of it, is relaxed. Which explication, whether it be more natural than ours, (that aſcribes the ſhrinking of the bladder to the preſſure of the air, that is let into the receiver) let the reader judge, who has conſidered what we have formerly objected againſt the examiner's Funiculus, and the relaxation of it upon the admiſſion of air.

As for the reaſon likewiſe he adds, why a perforated bladder does not alſo ſwell, namely, that by the hole, how little ſoever, the included air is ſucked out by the rarefied ambient, we leave it to the impartial reader to conſider, whether is the more genuine explication, either ours (againſt which he has nothing to object) or his, which to make clearly out he ought (according to what we formerly noted diſputing againſt his Funiculus) to ſhew us what kind of ſtrings they are; which, though, according to him, ſtrongly faſtened to the inſide of the receiver and the ſuperficies of the bladder, muſt draw juſt as forcibly one as another, how long ſoever they be without the bladder in compariſon of thoſe, that within the bladder draw ſo as to hinder the diduction of its ſides. For experience ſhews, that in a perforated bladder the wrinkles continue, as if there were no drawing at all.

And though he could deſcribe, how ſuch a ſtring may be contexť, yet our explication will have this advantage in point of probability above his, that whereas he denies not, that the air has ſpring and weight, as we deny his Funiculus to have any other than an imaginary exiſtence; and whereas he acknowledges, that

by the inſtrument the air about the bladder is exhauſted; to ſhew, that there needs no more than that, and conſequently no Funiculus, to draw aſunder the ſides of the bladder, we can confirm our explication by the formerly-mentioned experiment of the ingenious *Paſchal*, who carrying a flaccid foot-ball from the bottom to the top of an high mountain, found it to ſwell proportionably as he aſcended, and as the weight and preſſure of the ambient air decreaſed, and likewiſe to ſhrink again as he deſcended. And yet in this caſe there is no recourſe to be had to a Funiculus of violently-rarefied air, to draw aſunder every way the ſides of the foot-ball. But however the examiner will be able to defend his explication, it may ſuffice us, that he has objected nothing againſt ours.

EXPERIMENT V.

AGAINST the cauſe we aſſign of the fifth experiment he likewiſe objects nothing, but only aſcribes the breaking of the bladder to the ſelf-contraction of the rarefied air in the receiver. And therefore referring the reader to what we have newly ſaid about the laſt experiment, we will with our author paſs over the ſixth and ſeventh, to which he has no quarrel, and proceed to the eighth.

EXPERIMENT VIII.

THIS is that, wherein we mention our having broke a glaſs-receiver, which was not globular, by the exhauſtion of moſt of the inward air, whereby its debilitated preſſure became unable to reſiſt the unweakened preſſure of the outward air. But this explication the examiner confidently rejects in theſe words; *At profecto non videtur credibile, molliſſimum hunc aërem tam vehementer vitrum (tantæ præſertim craſſitudinis, quantæ ibidem dicitur) undique ſic comprimere, ut illud perfringat:* ‘ But ‘ truly it ſeems not credible, that this moſt ſoft ‘ air ſhould ſo vehemently compreſs a glaſs on ‘ all ſides (eſpecially one of that thickneſs ‘ there mentioned) as to break it.’ As if it were more credible, that the little air within (which, according to him, is ſo much thinner than common air) ſhould be able to act more powerfully upon the glaſs than the air without, which himſelf confeſſes to be a heavy body, and which not only reaches from the ſurface of the earth to the top of the higheſt mountains, but which (as may not improbably be argued from what we have elſewhere delivered) may, for aught we know to the contrary, be heaped upon the receiver to the height of ſome hundreds of miles, nay, to I know not how many thouſands, in caſe the atmoſphere be not a bounded portion of the air, but reach as high as it.

See part 2. c. 5.

As for the explication he ſubſtitutes in theſe words, *Verius itaque reſpondetur, ideo ſic fractum eſſe illud vitrum, quia per exhauſtionem illam latera ejus vehementiùs introrſum ſint attracta, quam ut (ob figuram illam reſiſtendo minus idoneam) reſiſtere potuerint. Cum enim incluſus aër lateribus vitri firmiſſimè adhæreat, nihil aliud erit aërem illum ſic exhaurire, quam fatagere latera vitri introrſum flectere:* ‘ It is ‘ therefore more truly anſwered, that the glaſs ‘ is therefore ſo broken, becauſe by that ex‘ ſuction its ſides are more vehemently drawn ‘ inwards than (by reaſon of the figure unfit ‘ for reſiſtency) they were able to reſiſt. For ‘ ſeeing the included air doth moſt firmly ſtick ‘ to the ſides of the glaſs, to draw out the air ‘ will be nothing elſe, but to endeavour to bend ‘ the ſides of the glaſs inwards.’ By what we have already diſcourſed about the Funiculus, the reader may eaſily diſcern what is to be anſwered. Nor does our author here ſhew us any way, by which his imaginary ſtrings ſhould take ſuch faſt hold of the ſides of the glaſs, as to be able to draw them together, notwithſtanding the reſiſtance they find from the cloſe texture of the body to be broken.

EXPERIMENT IX.

OUR explication of the ninth experiment he handles very ſeverely: for having briefly recited it, he propoſes his objection againſt it thus; *Sed profecto nimis longè videtur hoc à veritate recedere: poteſque vel inde ſolum ſatis refutari; quia ſi tanta ſit preſſura aëris ſic per tubum illum in phialam deſcendentis, ut ipſam phialam perfringat, deberet profecto incluſam, cui immergitur ille tubus, valde quoque ante fractionem phialæ commovere, bullulaſque in eadem excitare, &c. ut conſtat, ſiquis, inſufflando per illum tubulum, aquam vel mediocriter ſic premat. At certum eſt aquam, antequam frangatur ſic phiala, nec tantillum moveri; ut experienti conſtabit.* ‘ But truly this ſeems too ‘ far removed from truth, and may be by this ‘ alone ſufficiently refuted. Becauſe if the ‘ preſſure of the air, which deſcends by that ‘ tube into the phial, be ſo great as to break the ‘ phial itſelf, it ought certainly, before the ‘ breaking of the phial, very much to move ‘ the water, in which the tube is immerſed, and ‘ to excite bubbles in it, *&c.* as appears, if ‘ any one blowing through that tube doth ‘ make but an ordinary preſſure upon the ‘ water. But it is ſure, that the water, before ‘ the phial is broken, doth not move at all; as ‘ the experimenter will find.’

BUT I do confeſs, I do for all this think our explication more true, than well conſidered by our author. For the putting of water into the phial, that was broken, was done (as clearly intimated in the beginning of our narrative) upon a particular deſign, (as indeed we tried divers other things with our engine, not ſo much with immediate reference to the ſpring of the air, as to make uſe of ſuch trials in ſome other of our writings.) And accordingly in the ſecond trial mentioned in the ſame experiment, the water was omitted. But, notwithſtanding this water, the ſides of the glaſs being expoſed to the preſſure of the atmoſphere, had that whole preſſure againſt them before the exhauſtion of the receiver; ſo that there needed no ſuch blowing in of the air afreſh as our author imagines, to effect the breaking of the phial,

it

it being ſufficient for that purpoſe, that the preſſure againſt the convex ſuperficies of it was taken off by the exhauſtion of the receiver, the preſſure againſt the concave ſuperficies remaining as great as ever. And therefore we need not altogether deny what the examiner ſays, that *licet clauſus ſuperne fuiſſet tubulus ille, eodem tamen modo fracta ſine dubio fuiſſet phiala:* 'Though the tube had been ſhut at the top, 'the phial had doubtleſs been broken after the 'ſame manner.' For, ſince in ſuch caſes the air (as we have often taught) is ſhut up with the whole preſſure of the atmoſphere upon it, it may almoſt as eaſily break the glaſs as if it were unſtopt. And accordingly we mention, in the 36th experiment, the breaking of a thin glaſs hermetically ſealed, upon the receſs of the ambient air. But, how confidently ſoever our author ſpeaks, I thought fit to add the word *almoſt*, becauſe we obſerved in the 39th experiment, that ſuch thin phials (and thick ones will not break) are ſubject upon the withdrawing of the ambient air to retch a little, whereby the ſpring of the air within the phial might in ſome caſes (I ſay, in ſome) be ſo far weakened, as not to be able to break it, unleſs aſſiſted by the preſſure of the atmoſphere, wherewith it communicates, and which leans upon it. And when the phial does actually begin to break, then the purſuing preſſure of the outward air upon the yielding air within the phial may help to throw the parts of the glaſs more forcibly aſunder.

ALL the experiments from the 9th to the 17th excluſively our examiner leaving uncenſured, we may with him advance to the conſideration of the 17th.

The 17th EXPERIMENT *defended.*

IN this we relate how, when we made the Torricellian experiment, we ſhut up the reſtagnant mercury together with the tube and the ſuſpended mercurial cylinder (of about 29 inches) in our receiver, that by drawing off and letting in the air at pleaſure upon the reſtagnant mercury, and conſequently weakening and increaſing its preſſure, we might make it more clearly appear than hitherto had been done by experiment, that the ſuſpenſion of the mercurial cylinder, and the height of it, depended upon the greater or leſſer preſſure of the air. But againſt our explication of this experiment (which has had the good fortune to convince and ſatisfy many ingenious men) the examiner objects nothing in particular, contenting himſelf to have recourſe here alſo to his Funiculus. Yet two obſervations of ours he is pleaſed to take notice of.

THE firſt is, that though the quickſilver were exactly ſhut up into our receiver after the manner newly declared, yet the ſuſpended quickſilver did not deſcend: whence having ſaid, that I argue, that it is now ſuſtained not by the counterpoiſe of the atmoſphere, but by the ſpring of the air ſhut up in the receiver, he ſubjoins only this; *'Sed rectius ſane infertur, cylindrum illum nihil ibidem antea præſtitiſſe:* 'But it is more rightly thence inferred, that 'that cylinder did nothing there before.' But whether this be not *gratis dictum*, we leave the reader to collect from what we have formerly diſcourſed in the ſecond part of this defence of the ſpring of the air; eſpecially from that experiment, by which it appears, that ſpring may ſuſtain a far higher cylinder of quickſilver.

IN the ſecond obſervation he mentions of ours, he ſummarily recites our explication of the deſcent and aſcent of the mercury in the tube, by the debilitated and ſtrengthened ſpring of the air. But without finding fault with our application of that principle to the phænomena, he ſays, that he has ſufficiently refuted the principle itſelf in the fourth chapter, (which how well he has done, we have already ſeen;) and therefore explicates the matter thus: *Dico igitur* (ſays he) *argentum per illam exhauſtionem ſic in tubo deſcendere, quod deorſum trahatur ab aëre, qui incumbit argento reſtagnanti: ſiquidem incumbens ille aër jam per exhauſtionem valde rarefactus & extenſus ſeſe vehementer contrahit, & contrahendo conatur etiam ſubjectum ſibi argentum reſtagnans è ſuo vaſculo elevare; unde fit ut (argento illo reſtagnante minus jam gravitante in fundum ſui vaſculi) argentum quod eſt in tubo deſcendat; ut per ſe patet. Adeoque mirum non eſt, quod, ingrediente poſtea aëre externo, rurſum argentum aſcendat, cum per illum ingreſſum vis illa ſic elevans argentum reſtagnans debilitetur:* 'I 'ſay then, that the quickſilver doth by that exhauſtion ſo deſcend in the tube, becauſe it is 'drawn downwards by the air incumbent up'on the reſtagnant quickſilver. For that in'cumbent air, being by its exhauſtion greatly 'rarefied and extended, vehemently contracts 'it ſelf, and by this contraction doth endea'vour to lift the reſtagnant mercury out of its 'veſſel; whence it comes to paſs, that (the re'ſtagnant mercury now leſs gravitating upon 'the bottom of its veſſel) the quickſilver in the 'tube muſt deſcend, as is manifeſt in itſelf: ſo 'that it is no wonder, that the external air 'afterwards entering, the quickſilver again aſ'cends, ſeeing by that ingreſs the force, which 'elevates the reſtagnant quickſilver, is weaken'ed.' But this explication ſuppoſing ſuch a Funiculus as we have already ſhewn to be but fictitious, the reader will eaſily gather what is to be judged of it from what has been already delivered. Wherefore I ſhall only ſubjoin, that by this explication, were it admitted, there is only an account given of that part of our ſeventeenth experiment, which relates to the deſcent of the mercury below its wonted height, and its re-aſcent to it. But as for our having, by the forcing in ſome more air into the receiver, impelled the quickſilver to a conſiderably-greater height than it is wont to be ſuſtained at in the Torricellian experiment, I confeſs I underſtand not how the examiner gives an account of it in the following words, (which are immediately annexed to thoſe we laſt recited of his, and which are all that he employs to explicate this notable phænomenon:) *Atque hinc etiam redditur ratio alterius, quod ibidem quoque notatur, nempe quod per violentam intruſionem aëris externi in recipientem aſcenderit argentum notabiliter ſupra digitos 29½. Nam ſicut per extractionem aëris argentum infra ſtationem detrahitur, ſic etiam per intruſionem novi ſupra eandem elevabitur:*

bitur: 'And hence is a reaſon alſo given of 'another thing, which is there noted, namely, 'that by the violent intruſion of the external 'air into the receiver the quickſilver aſcended 'conſiderably above 29 inches and an half. 'For as by the extraction of the air the quick-'ſilver is depreſt below its ſtation, ſo by the 'intruſion of new air it is elevated above it.' For in this paſſage I ſee not how he himſelf does not rather repeat the matter of fact, than give any account how it is performed. And if it be alledged on his behalf, that according to his principles it may be ſaid, that, upon the preſſure of adventitious air upon the reſtagnant mercury, the Funiculus in the tube, that was not able before to draw it up above 29½ inches, is now enabled to draw it up higher; I demand upon what account this new air does thus preſs againſt the reſtagnant mercury, and impel up and ſuſtain that in the tube. It will not be ſaid, that it is by its weight; for as much mercury as may be thus impelled up above the uſual ſtation will weigh a great many times more than the air forced into the receiver. And therefore it remains, that the additional air counterpoiſes the additional mercury by its ſpring. And if we conſider withal, that there is no reaſon to doubt, (eſpecially conſidering what we have formerly delivered upon trial touching the power of compreſt air to impel up quickſilver) but that, had we not been afraid of breaking our veſſel, we might by forcing more air into the receiver have impelled it up to the top of the tube, and kept it there; we ſhall ſcarce deny, but that, ſuppoſing there could be no ſuch Funiculus as our examiner's *in rerum natura*, the preſſure of the incumbent air alone might ſuffice to keep a correſpondent cylinder of mercury ſuſpended; and that without any attraction of the reſtagnant mercury by a Funiculus of violently-diſtended air in the receiver, the quickſilver in the tube may be made to reſt at any height greater or leſſer, provided it exceed 30 inches, only becauſe its weight is juſt able to counterbalance the preſſure of the contiguous air.

I KNOW not whether I may not add (to expreſs an unwillingneſs to omit what ſome may think proper to do my adverſary right) that it may be ſaid for the examiner, that he in the 11th page acknowledging with us a power in the air to recover, its due extenſion, if it be crouded into leſs room than its diſpoſition requires; a man may from that principle ſolve the phænomena in queſtion, by ſaying, that the air in the receiver being forcibly compreſſed by the intruſion of freſh air into the ſame veſſel, does by its endeavour to recover its due expanſion preſs upon the reſtagnant mercury, and force up ſome of it into the tube. But this explication, though it agree with what the author teaches in a place very diſtant from his notes upon our 17th experiment, now under debate; yet ſtill it is not clear to me, how, by what he ſays in theſe notes, the phænomenon is accounted for as the word *hinc* imports it to be. But otherwiſe I need not quarrel with the explication, ſince without recurring to the Funiculus for the ſuſtaining of the additional mercury, the ſolution of the phænomenon is given upon the ſame principle, that I employ.

EXPERIMENT XVIII.

OUR examiner in his animadverſion upon the 18th experiment, having recited my conjecture as the cauſe, why a cylinder of mercury did in winter riſe and fall in the tube ſometimes as water is wont to do in a weather-glaſs, according to the laws of heat and cold, and ſometimes quite contrary thereunto; adds, that this experiment does ſtrongly enough overthrow our hypotheſis of the atmoſpherical cylinder, and clearly ſhew, that the quickſilver is not ſuſtained by it: *Nam* (ſays he) *ſi hoc ab eo ſuſtentatum fuiſſet, debuiſſet potius frigidiore tempore aſcendere quam deſcendere, eo quod aër tunc multo denſior eſſet & gravior. Itaque non ſuſtentatur argentum ab aëris æquipondio, ut aſſeritur:* 'For if it were kept up by that, it 'ought rather to aſcend than deſcend in colder 'weather, becauſe the air then would be more 'denſe and heavy. Therefore the quickſil-'ver is not upheld by the æquilibrium of air, 'as is aſſerted.' And by the ſame argument he concludes againſt the mercury's being ſuſtained by the ſpring of the air. But in his animadverſions upon this experiment he ſeems to have been too forward to reprehend; for he neither well confutes my conjecture, nor ſubſtitutes ſo much as a plauſible one in the ſtead of it. And as to his objection, I anſwer,

FIRST, That it doth not conclude; becauſe that as ſometimes the quickſilver in the tube did riſe in warmer, and fall in colder weather; ſo at other times it did rather emulate the aſcent and deſcent of water in a weather-glaſs.

SECONDLY, Though it be true, that cold is wont to condenſe this or that parcel of air, and that a parcel of air may be made heavier by condenſation; yet that is in regard of the ambient air, that retains its wonted laxity, in which the condenſed air is weighed. But our author has not yet proved, that in caſe the cold of the winter ſhould condenſe the whole incumbent atmoſphere, it would then gravitate ſenſibly more upon the reſtagnant quickſilver than before. As a pound of wooll will not ſenſibly vary its weight, though the hairs, whereof it is compoſed, be made to lie ſometimes in a looſer, ſometimes in a cloſer order.

AND, thirdly, his objection does as little agree with his doctrine as with my conjecture: for in the 50th page, where he gives us an account, according to his principles, of the riſing and falling of water in a weather-glaſs, and compares it with the ſuſpenſion of quickſilver, he tells us, *Hinc fit quod, contracto hoc Funiculo per frigus, aqua illa tempore frigido aſcendat, deſcendat autem tempore calido, eo quod per calorem Funiculus ille dilatetur:* 'Hence it comes 'to paſs, that this Funicle being contracted by 'the cold, the water doth aſcend in cold wea-'ther; but doth deſcend in hot, becauſe by 'heat the Funicle is dilated.' So that, according to the examiner himſelf, the quickſilver ought to have aſcended in colder, and deſcended in warmer weather. Now, although I propoſed

my

my thoughts of the difficult phænomenon under conſideration but as a conjecture, and therefore ſhall be ready to alter them, either upon further diſcovery or better information; yet I ſee not why it ſhould be poſt-poſed to the examiner's, who, though he rejects our explication, ſubſtitutes no other than what may be gathered from theſe words; *Ego certè non dubito, quin dentur hujuſmodi occultæ cauſæ, quibus Funiculus ille ſubtilis, quo in tubo ſuſpenditur argentum (ut dictum eſt capite decimo) modo producatur, modo abbrevietur, &c. ſicque argentum nunc demittat, nunc elevet:* 'I truly do not 'doubt, but there are ſome ſuch occult cauſes, 'by which the ſlender Funicle, that ſuſpends '(as we mentioned in the tenth chapter) the 'quickſilver in the tube, is ſometimes lengthened, ſometimes ſhortened, and ſo doth ſometimes let down, and ſometimes lift up the 'quickſilver.' For, ſince we have made it probable, that the copious fumes ſometimes ſuddenly aſcending into the air, and rolling up and down in it, ſometimes ſenſibly altering (if good authors may be credited) the refraction of it, and ſince ſome other cauſes, mentioned in our eighteenth experiment, may alter the denſity and gravity of the air, that leans upon the reſtagnant mercury; I ſuppoſe the reader will think it more intelligible and probable, that alterations, other than thoſe produced by heat and cold, may happen to the incumbent atmoſphere, which freely communicates with the neighbouring air, and may thereby become ſometimes more ſtufft, and ſometimes more deſtitute of adventitious exhalations, than that ſuch changes ſhould happen to a Funiculus included in glaſs; which, according to our author, is impervious to the ſubtileſt ſteams that are, and concerning which he offers not ſo much as a conjecture, upon what other account it can happen to be ſometimes contracted, and ſometimes ſtretched.

EXPERIMENT XIX.

UPON this the examiner has only this ſhort animadverſion; *In decimo nono oſtendit aquam eodem modo per exhauſtionem recipientis deſcendere, quo in præcedente deſcendere oſtenderat argentum vivum; cujus cum eadem ſit ratio, non eſt cur amplius ei inſiſtamus.* 'In the 19th he 'ſhews, that water doth in the ſame manner 'deſcend upon the exhauſting the receiver, as 'he had ſhewn quickſilver in the foregoing 'chapter to deſcend. Of both which, ſeeing 'there is the ſame cauſe, there is no reaſon we 'ſhould any longer inſiſt on this.' In which words, ſince he offers nothing new or peculiar to ſhew any incongruity in our explication to our principles, which agree very well with the new phænomena of the experiment; we are content to leave the reader to judge of the hypotheſes themſelves, which of the two is more probable, either ours, that only requires, that the air in the receiver ſhould equally reſiſt a cylinder of water and of quickſilver, when their weight is but the ſame, though their altitudes be not; or the examiner's, which exacts, that (according to what we formerly elſewhere noted) bodies of ſuch differing nature and texture as quickſilver and water ſhould need but juſt the ſame weight or ſtrength to rarefy them into a Funiculus.

EXPERIMENT XX.

IN his examen of this experiment our author makes me infer from the phænomena he repeats, that not only the air, but the water alſo has a ſpring. But though I ſuſpect not, that he does wilfully miſtake my ſenſe, yet by what I write in this and the following experiments the reader may well enough perceive, that I ſpoke but very doubtfully of a ſpring in the water; nay, and that I did in the 58th page expreſly teach, that the intumeſcence of it might (at leaſt in great part) proceed from that of the ſmall parcels of air, which I thought to be uſually harboured in the body of that liquor.

BUT whereas I aſcribe the appearance of the bubbles in the water to this, that upon the exhauſtion of ſome of the air incumbent on the water, the preſſure of what remains is much debilitated, whereby the little particles of air lurking in the water are allowed to expand themſelves into bubbles; he rejects this explication as manifeſtly falſe: *Nam* (ſays he) *ſi ita fieret, deberent profecto hujuſmodi bullulæ, non è fundo vaſis ſic aſcendere, (uti tam in hoc quam in ſequentibus experimentis, in quibus de iſtis bullis ſemper agitur, aſſeritur) ſed è ſuperiore parte aquæ, ubi minus premuntur, ut per ſe eſt manifeſtum.* *Sed contra manifeſtè*
'For if it were done ſo, theſe bubbles ought 'not ſo to have aſcended from the bottom of 'the veſſel, (as it is aſſerted they did, both in 'this and the following experiments that treat 'of bubbles) but from the upper part of the water, where they are leſs compreſt; as it is 'apparently manifeſt.' But why he ſhould be here ſo peremptory, I confeſs I do not, for all this objection, yet ſee: for in the bottom of the next page he ſays, he will not deny, but that aërial particles latitant in the other parts of the water (he had before ſpoken of the bottom of it) may be extended into bubbles by his way of rarefaction. And that we particularly mentioned the riſing of bubbles, even from the bottom of the water, was becauſe that circumſtance ſeemed to deſerve a peculiar note; and not (as he ſeems to imagine) as if the bubbles did not alſo riſe from the ſuperior parts of the liquor, ſince we did take notice of it about the middle of the 56th page. * And we often in this and the following experiments obſerved, that the aſcending bubbles grew bigger the nearer they came to the top. Which agrees more clearly with our hypotheſis, wherein their conſpicuous ſwelling, as they aſcend, is attributed more to the leſſening of the preſſure of the incumbent air, than to the decrement of the weight of the incumbent water, (ſince when the ſurface of this liquor is leaned upon by the atmoſphere, the aſcending bubbles ſcarce ſenſibly increaſe in veſſels

* See alſo in the 43d Experim. theſe paſſages,—*And this Effervescence was ſo great in the upper part of the water, &c.* As alſo,—*Effervescence was confined to the upper part of the water, unleſs, &c.*

no deeper than ours) than with the explication, which the examiner gives in theſe words; *Reſpondeo, aquam per illam aëris exhauſtionem non ſponte ſic aſcendere, ſed ſurſum violenter trahi, ac elevari à rarefacto illo aëre ſeſe contrahente. Quemadmodum enim aqua aliqualem patitur compreſſionem (ut experientiâ conſtat) ita & aliqualem quoque hic patitur diſtenſionem. Atque hinc clarè patet, cur potius à fundo vaſis quam à parte aquæ ſuperiore oriantur hujuſmodi bullæ. Cum enim vehemens illa ſuctio conetur aquam à fundo phialæ elevare, naſcitur ibidem ſubtilis quædam materia, quæ in bullas converſa ſic aſcendit, uti capite decimo quinto in quarto experimento dictum eſt.* 'I anſwer, that the water, 'upon exhauſtion of the air, doth not ſo aſcend 'of its own accord, but is violently drawn 'or lifted upwards by that rarefied air con-'tracting itſelf. For as water doth ſuffer ſome 'compreſſion, (as appears by experience,) ſo 'here alſo it ſuffers ſome diſtenſion. And 'hence it is clearly manifeſt, why theſe bubbles 'ſhould ariſe rather from the bottom of the 'veſſel, than from the upper part of the water. 'For when that vehement ſuction doth endea-'vour to elevate the water from the bottom 'of the phial, there ariſes there a certain ſubtile 'matter, which being turned into bubbles, doth 'ſo aſcend, as is mentioned in the 15th 'chapter and the 4th experiment.' For, whatever he may think, it does not hence ſo clearly appear, how the endeavour only of the Funiculus to draw up the water from the bottom of the phial, to which, that endeavour notwithſtanding, it remains contiguous, ſhould generate in ſome parts of the bottom of the glaſs, and not in others, ſuch a ſubtile matter as he tells us of. And I ſuppoſe the reader will, as well as I, wiſh he had more intelligibly declared, how this ſtrange generation of ſubtile matter comes to be effected. And I preſume it will likewiſe be expected, that he alſo declare, why both in our caſe and in the Torricellian experiment the bubbles grow ſo much larger by being nearer the top of the liquor; if, as he rejects our explication of this circumſtance, the effect of the ſuction he ſpeaks of be greater upon the lower part of the liquor than the upper, to which alone nevertheleſs his Funiculus, that is ſaid ſo to draw the liquor, is contiguous.

Our author making no particular objection againſt the ten following experiments, we alſo ſhall paſs them by, and fall with him upon the conſideration of the 31ſt experiment.

EXPERIMENT XXXI.

Upon this our author having recited our conjecture, as the cauſe why two very flat and ſmooth marbles ſtick ſo cloſely together, that by lifting up the uppermoſt you may take up alſo the lowermoſt, approves my way of examining that conjecture. But whereas I ſay, that the reaſon, why, though the marbles were kept together by the preſſure of the ambient air, yet they did not fall aſunder in our exhauſted receiver, no not though a weight of four ounces were hung at the lower ſtone, might be, that by reaſon of ſome ſmall leak in the receiver the air could not be ſufficiently drawn out; yet he tells us, with his wonted confidence, *Certum eſſe ſententiam illam vel hoc ſolo experimento ſatis refelli*: 'It is cer-'tain, that that opinion is ſufficiently refuted 'by this ſingle experiment.' But poſſibly he would have ſpoken leſs reſolutely, if he had made all the trials about the adheſion of marbles, that we relate ourſelves to have made in the ſhort hiſtory we have publiſhed of *fluidity and firmneſs*. For our examiner ſpeaks, as if all that we aſcribe to the air in ſuch experiments were to ſuſtain the lower marble with the weight perhaps of a few ounces; whereas in caſe the air be kept from getting in at all between the ſtones, it may (according to our hypotheſis) ſuſtain a weight either altogether, or well-nigh equal to that of a pillar of air as broad as the baſis of the lower marble, and as long as the atmoſphere is high, or to the weight of a pillar of quickſilver of the ſame thickneſs, and about thirty inches long; theſe two pillars appearing by the Torricellian experiment to counterpoiſe each other. And therefore ſince in the ſeventeenth experiment, when we had exhauſted our receiver as far as we could, there remained air enough to keep up in the tube a cylinder of about an inch long of quickſilver; and ſince the broader the contiguous marbles are, the greater weight faſtned to the lowermoſt may be ſuſtained by the reſiſtance of the air, (as is obvious to him, that conſiders the hypotheſis, and as we have proved by experiment in the fore-mentioned tract) it need be no wonder, that the air remaining in the receiver ſhould be able to ſupport the lowermoſt marble, whoſe diameter was near two inches, and a weight of four ounces, thoſe two weights being inferior to that of a mercurial cylinder of that diameter and an inch in length. And though it were not, yet we are not ſure, that the receiver was as well emptied when we made the 31ſt experiment, as when we made the 17th. And (if my memory does not much miſinform me) it was with the ſame pair of marbles, that in the preſence of an illuſtrious aſſembly of virtuoſi, (who were ſpectators of the experiment,) the uppermoſt marble drew up the lowermoſt, though that was clogged with a weight of above 430 ounces.

As for the account the examiner ſubſtitutes of our phænomenon, I know not whether many readers will acquieſce in it. For, not to inſiſt upon the objection, which himſelf takes notice of, that, according to him, the diſtended air in the receiver ſhould draw aſunder the adhering marbles; his explication ſuppoſes, that there cannot naturally be a vacuum: whence he infers that, *Neceſſe erat, ut lapis ille non aliter deſcenderet, quàm relinquendo poſt ſe tenuem hujuſmodi ſubſtantiam, qualis ab argento vivo aut aquâ ſic deſcendentibus relinqui ſolet.* 'It muſt 'needs be, that that ſtone could not otherwiſe 'deſcend, than by leaving behind it ſuch a 'thin ſubſtance, as is left by quickſilver or 'water deſcending in like manner.' But whereas he adds, that the cauſe of the obſtinate adheſion we meet with in our caſe is, that ſuch

a ſubſtance is far more difficult to be ſeparated from marble than from quickſilver, or any other kind of body; that aſſertion is precarious. And though I have tried experiments of this nature with ſtones of ſeveral ſizes, perhaps an hundred times, yet I never could find, that by their coheſion they would ſuſtain a weight greater, than that of a pillar of the atmoſphere that preſt againſt the lowermoſt: which is a conſiderable circumſtance, that much better agrees with our explication than our adverſary's. And whereas he further ſays, *Unde exiſtimo planè, ſi perfectè complanata fuerint duo marmora ſic conjuncta, ita ut nullus omnino aër inter utrumque mediaret, non poſſe ea ullis humanis viribus ab invicem divelli.* 'Whence I plainly conceive, that if two 'perfectly poliſhed marbles were ſo joined, that 'no air at all were left between them, they 'could not be drawn aſunder by all the power 'of man.' I hope I need not tell the reader, that whether or no this agree with what he had immediately before taught of the ſeparableneſs of a ſubtile ſubſtance, even from marble, ſo bold and improbable an aſſertion requires the being countenanced with a much better proof, than the only one he ſubjoins in theſe words; *Uti etiam confirmat exemplum, quod ibidem adducit author de lamina ænea, tabulæ cuidam marmoreæ ita adhærente, ut à lacertoſo juvene, de ſuis viribus gloriante, non potuerit per annulum centro ejus affixum inde elevari.* 'Which alſo 'is confirmed by the example the author there 'brings of a braſs plate ſticking ſo cloſe to a 'marble table, that by a luſty youth, who 'boaſted of his own ſtrength, it could not be 'lifted off by a ring fixed to its centre.' For ſure there is great odds betwixt the ſtrength of a man unaſſiſted by an engine, and the utmoſt extent of human power. And indeed, according to our hypotheſis, and without having recourſe to nature's dreading of a vacuum, the caſe is clear enough. For, ſuppoſing the plate to be of any conſiderable breadth, the pillar of the atmoſphere, that leaned upon it, and muſt at the inſtant of its deſerting the ſuperficies of the table all at once be lifted up with it, may well exceed the force of a ſingle man, eſpecially in an inconvenient poſture; ſince by the coheſion of a pair of marbles of about three inches diameter, I did, with my own hands, take up above a thouſand and three hundred ounces.

EXPERIMENT XXXII, *and* XXXIII.

AGAINST our explication of theſe two, which our author examines together, he objects nothing peculiar, but contents himſelf to explicate them by his Funiculus. Wherefore neither ſhall we need to frame any peculiar defence for it, eſpecially if the reader will be pleaſed to refer hither as much of what we oppoſed to his animadverſion on the third experiment, as is juſtly applicable to our preſent controverſy. Our author indeed endeavours to prove his explication by ſaying, that the diſtended air in the exhauſted cylinder draws up the ſucker with the annexed weight: *Eodem ferè modo, quo videmus in cucurbitulis dorſo ægrotantis applicatis, in quibus, extincta jam flammâ, rarefactus aër ſe contrahens carnem tam vehementer, uti videmus, elevat attrahitque intra cucurbitulam.* 'Almoſt in the ſame manner 'as we ſee in cupping-glaſſes applied to a 'patient's back, in which the flame being ex'tinct, the rarefied air contracting itſelf doth 'ſo vehemently (as we ſee) lift up, and draw 'the fleſh within the glaſs.' But that phænomenon is eaſily enough explicable in our hypotheſis, by ſaying, that upon the vaniſhing of that heat, which ſtrengthned the preſſure of the included air, the ſpring of it grows too weak to reſiſt any longer the preſſure of the ambient air; which thereupon thruſts the fleſh and neighbouring blood of the patient into the cupping-glaſs, almoſt after the ſame manner, as we formerly taught the pulp of the finger to be thruſt into the deſerted cavity of the glaſs-tube in the Torricellian experiment.

EXPERIMENTS XXXIV, XXXV, *and* XXXVI.

TO theſe our author ſaying nothing but this, *In his tribus nihil peculiariter occurrit hic explicandum, cujus ratio ex jam dictis non facile pateat:* 'In theſe three there is nothing 'occurs to be peculiarly here explicated, the 'account of which is not eaſy from what is 'already delivered:' we alſo may be allowed to pretermit them, and paſs on to

EXPERIMENT XXXVII.

OF the appearance of light or whiteneſs, mentioned in this experiment, the examiner confeſſes, that we have aſſigned a cauſe probable enough, by referring it to the vehement and ſudden commotion of the included air. And indeed though I do ſtill look upon ſome of the things; that I heſitantly propoſed about this difficult phænomenon, but as mere conjectures, and though he annexes his explication of it, yet I ſee not but that it is coincident with ours, or not better than it. For, to what I ſaid of the commotion of the parts of the air, he adds only in two or three ſeveral places their being violently diſtended; which how it improves the explication of the phænomenon, I do not readily ſee. And whereas he ſubjoins, *Exiſtimo autem dicendum potius candorem illum eſſe lumen quoddam reflexum, quam innatum, eo quòd (uc teſtatur author) in tenebris non appareat, ſed ſolum de die aut accenſa candela:* 'But I think, that whiteneſs 'ſhould be rather called a reflex than an in'nate light, becauſe, as the author bears wit'neſs, it appears not in the dark, but only in 'the day, or by candle-light:' I preſume the attentive reader will eaſily diſcern, that his opinion is much-what the ſame that I propoſed and grounded on the ſame reaſon. But the chief difficulty in this abſtruſe phænomenon, namely, why we meet with it but ſometimes, our examiner's explication leaves untouched.

EXPE-

EXPERIMENTS XXXVIII, *and* XXXIX.

AGAINST theſe our author makes no peculiar objections.

EXPERIMENTS XL, *and* XLI.

BUT in his animadverſions upon theſe, having told the reader, that I ſeem to aſcribe the ſudden extinction of the included animals to the exceſſive thinneſs of the air remaining in the receiver, made by the receſs of what was drawn out, unfit for reſpiration; he adds reſolutely enough, *Verum impoſſibile videtur, ut hujuſmodi animalcula ob ſolum defectum craſſioris aëris tam cito moriantur:* 'But it ſeems 'impoſſible, thatſuch animals ſhould die ſo ſoon 'only for want of a thicker air.' But gives no other reaſon, than that they die ſo ſoon, which is no more than what he ſaid in the newly-cited words, and beſides is grounded upon ſomething of miſtake. For the creatures he mentions were a bee, a fly, and a caterpillar, and thoſe included too in a ſmall receiver, which could be ſuddenly exhauſted: and theſe indeed became moveleſs within a minute of an hour; but that minute was not (as the word is often uſed to ſignify in Engliſh) a moment, but the ſixtieth part of an hour. And though theſe inſects did in ſo ſhort a time grow moveleſs, yet they were not ſo ſoon killed; as appears by the narrative. The ſanguineous animals, that did indeed die, were killed more ſlowly. And I remember, that having purpoſely inquired of a man, (uſed to go under water by a the help of an engine, wherein he could carry air with him to the bottom of the ſea) how long he could endure, before he was accuſtomed to dive, without breathing or the uſe of a ſponge *? he told me, that at firſt he could hold out about two or three minutes at a time: which made me think, that divers become able to continue under water ſo long, either by a peculiarly-convenient conſtitution of body, or by a gradual exerciſe. And I am apt to think, that he did, as men are wont to do, when he ſaid two or three minutes, mean what is indeed a much ſhorter time than that, when exactly meaſured, amounts to. For, havin g purpoſely made trial upon a couple of moles, that were brought me together alive, one of them included in a ſmall, though not very ſmall, receiver, was between two and three minutes in killing; whereas the other being immediately after detained under water, did not there continue full a minute and a quarter, before it finally ceaſed from giving any ſign at all of life. By which trial it may appear, that it is not impoſſible, that the want of reſpiration ſhould diſpatch an animal in as little time as is mentioned in the experiment I am now defending. And indeed our author either ſhould have proved, that it is not poſſible for the want of air to deſtroy animals ſo ſoon, or ſhould have given us ſome better account of the pheænomenon. For whereas he teaches us, that, according to his doctrine, the little animals above-mentioned were ſo ſoon killed; *Quia per rarefactam illum aërem ſeſe contrahentem extractus ſit eorum halitus:* 'Becauſe by 'the ſelf-contraction of the rarefied air their 'breath is drawn out of their bodies:' I ſee not, that hereby, if he explicate the phænomenon otherwiſe than we, he explains it better; for he ſeems to ſpeak, as if he thought, his halitus to be ſome peculiar part of the animal, in which his life reſides. And beſides, he ſeems not to conſider, that whereas, according to me as well as according to him, the air contained in the lungs, (ſuppoſing theſe animalcula have any,) muſt in great part paſs thence into the receiver; (for whether that be done by the ſpring of the air itſelf, that was harboured in the lungs, or the traction of the more rarefied air in the receiver, is not material in our preſent caſe;) the examiner muſt, as well as I, render a reaſon, why the extenuation or receſs of the halitus ſhould cauſe the haſty death of the included animals; and condemning my conjecture, he ought to have ſubſtituted another reaſon. And though he ſubjoins theſe words, and concludes with them; *Atque hinc quoque ortæ ſunt vehementes illæ convulſiones, quas ante mortem paſſas eſſe aviculas quaſdam memorat ibidem author:* 'And thence alſo 'aroſe thoſe vehement convulſions, which the 'author there mentions certain ſmall birds to 'have endured before their death:' Yet I doubt not but the reader will think it had not been amiſs, that the author had more intelligibly reduced theſe tragick ſymptoms from his aſſumption, for the ſake of thoſe, that are not anatomiſts and phyſicians enough to diſcern how his Funiculus could produce theſe effects.

FOR my part, as in the 41ſt experiment I tendered my thoughts concerning reſpiration but doubtingly, ſo I am yet unwilling to determine reſolvedly in a matter of that difficulty.

EXPERIMENTS XLII, *and* XLIII.

IN his examen of theſe two laſt of our phyſico-mechanical experiments, the author contents himſelf to endeavour to explicate the phænomena recited in them by the contraction of the rarified air; which, according to him, endeavours to draw up the ſubjacent water out of the phial, whereby it vehemently diſtends the parts of that water, as he taught in the like caſe upon the 20th experiment. But ſince we have already conſidered his animadverſion upon that, although this preſumed diſtenſion of the water is not viſible, that we have obſerved, when cold water, that has been at firſt freed from his interſperſed air, is put into the receiver, notwithſtanding that the Funiculus ſhould in that caſe alſo diſtend it; we are ſo afraid of tiring out the reader's patience by the frequent repetition of the ſame things, that we will leave it to him to judge, which of the two explications, the examiner's or ours, is to be preferred,

* See more concerning this objection in the anſwer to it, as it is propoſed by Mr. *Hobbes*.

preferred, without troubling him and ourſelves with defence of accounts, againſt which our adverſary does not here make any peculiar objections.

AND thus have we by God's aſſiſtance conſidered what the examiner hath been pleaſed to oppoſe, either againſt our particular explications, or againſt the hypotheſes, that divers of them ſuppoſe: wherein I have been the more particular and prolix, becauſe I would willingly excuſe my ſelf and others from the trouble of any more diſputes of this kind. I hope there is not in my anſwers any thing of aſperity to be met with; for I have no quarrel to the perſon of the author, or his juſt reputation; nor did I intend to uſe any more freedom of ſpeech in the anſwering his objections, than his reſolute way of propoſing divers of them made it, on thoſe occaſions, needful for the caution of thoſe readers, who are not acquainted with our differing ways of writing, and perhaps have not obſerved that ſome men are wont to conſider as much what they propoſe but with a perhaps, or ſome ſuch expreſſion of diffidence, as others do what they deliver far more reſolutely. And though being very far from being wedded to my opinions, I am ſtill ready to exchange them for better, if they ſhall be duly made out to me, (which I think it poſſible enough they may hereafter be;) yet peradventure the reader will think with me, that the examiner has not given me cauſe to renounce any of them, ſince the objections he has propoſed againſt me have been ſufficiently anſwered, and ſince the hypotheſis he would ſubſtitute in the room of ours (beſides that it is partly precarious) ſuppoſes things, which divers of the eminenteſt wits of our age (otherwiſe of differing opinions) profeſs they cannot admit, or ſo much as underſtand: whereas the weight and ſpring of the air are not denied by our author himſelf, and are demonſtrable by experiments, that are not controverted betwixt us. Which things I repreſent for the defence of what I think the truth, and not to offend my learned adverſary, who ſhall have my free conſent to be thought to have failed rather in the choice than in the management of the controverſy. Though, ſince this paſſes for his firſt book, and ſince, conſequently, he is not like to have been provoked, or engaged in point of reputation, to challenge me or any of thoſe far more eminent perſons he has named among his adverſaries, I am induced by the ſeverity, wherewith I have known eminent Virtuoſi ſpeak of his attempts, and particularly of his Funiculus, to fear, that ſome of thoſe he has needleſſly oppoſed, will be apt to apply to him that of St. *Auſtin* againſt ſome of his adverſaries, that had diſputed againſt him with much more ſubtilty than reaſon, *In mala cauſa non poſſunt aliter, at malam cauſam quis eos coegit habere?* 'In a bad cauſe they can do no other; but 'who compelled them to undertake a bad 'cauſe?' But this notwithſtanding, I am, as I was going to ſay, content, my adverſary ſhould be thought to have ſaid for his principles as much as the ſubject will bear; nor would I have it made his diſparagement, that I have declared that his whole book has not made me depart from any of my opinions or explications, ſince his hypotheſis and mine being inconſiſtent, it may be looked upon as a ſign rather that each of us have, than that either of us have not, reaſoned cloſely to his own principles, that the things we infer from our contrary ſuppoſitions do ſo generally diſagree.

An Explication of RAREFACTION.

THE chief arguments of the author of a certain treatiſe *De corporum inſeparabilitate*, whereby he endeavours to invalidate the hypotheſis of the weight and ſpring of the air, and to ſet up and eſtabliſh inſtead thereof an unintelligible hypotheſis of attraction, performed by I know not what ſtrange imaginary Funiculus, are only five; two againſt the former, and three for the latter. The firſt of which is, that the weight and ſpring of the air are not ſufficient to perform the effects aſcribed to them: the ſecond, that could they be performed by that hypotheſis granted, yet the way of this ſtrange ſpring it ſelf is not intelligibly explained or explicable by the defenders of it. Now the former of theſe being little elſe but a bare affirmation, and the latter bearing ſome ſhew of demonſtration, I ſhall endeavour to examine it as I find it ſet down in his 20th, 21ſt, 22d, 23d and 24th chapters, to which (eſpecially the 23d) he very often in his book refers the reader for ſatisfaction, pretending there to evince, that rarefaction cannot be made out any otherwiſe than by ſuppoſing a body to be in 2, 3, 4, 10, 100, 1000, 1000000 of places at the ſame inſtant, and adequately to fill all and every one of thoſe places.

FIRST therefore, we will examine his negative, and next his affirmative, arguments for this ſtrange hypotheſis.

HIS negative I find in the 20th chapter, where he endeavours to confute the two ways of explicating the rarefaction and ſpring of the air, namely, that of the Vacuiſts and that of the Pleniſts.

CONCERNING the firſt of theſe, we find him conclude it impoſſible, firſt, becauſe he had before proved, that there can be no vacuum, which being done by a circle (*viz.* there is no vacuum in the tube, becauſe nature abhors a vacuum, and we ſee nature abhors a vacuum, becauſe ſhe will not ſuffer a vacuum in the tube above the mercury, but, to prevent it, will continually ſpin the quickſilver into ſuperficies, and never diminiſh the body of it) will ſuffer me to paſs to his next; which is, that this way is falſe, becauſe in the experiment of the carp's bladder the air is rarefied 1000 times bigger; nay, in reſpect of the body of gold, it has 1000000 times leſs matter in equal ſpaces. And

this, ſays he, is a phænomenon, that is impoſſible ever to be made out by interſperſed vacuities. Now that the Vacuiſts cannot preſently, by ſo bold an aſſertion as this, be made to forſake their principles, he may perceive by theſe following ſolutions, which I ſhall give of all the phænomena he recites, flowing naturally from an hypotheſis, that I ſhall for the preſent aſſume. Let us ſuppoſe then the particles of bodies, at leaſt thoſe of the air, to be of the form of a piece of ribbon, that is, to be very long, ſlender, thin and flexible *laminæ*, coyled or wound up together as a cable, piece of ribbon, ſpring of a watch, hoop, or the like, are: we will ſuppoſe theſe to have all of them the ſame length, but ſome to have a ſtronger, others a weaker ſpring. We will further ſuppoſe each of theſe ſo coyled up to have ſuch an innate circular motion, as that thereby they may deſcribe a ſphere equal in diameter to their own, much after the manner that a meridian turned about the poles of a globe will deſcribe by its revolution a ſphere of the ſame diameter with its own in the air. By this circular motion the parts of the *laminæ* endeavouring to recede from the center or axis of their motion, acquire a ſpringineſs outward like that of a watch-ſpring, and would naturally fly abroad until they were ſtretched out at length; but that being incompaſſed with the like on every ſide, they cannot do it without the removal of them, as not having room ſufficient for ſuch a motion. And the faſter this circular motion is, the more do the parts endeavour to recede from the axis, and conſequently the ſtronger is their ſpring or endeavour outward. Theſe ſpringy bodies thus ſhaped and thus moved are ſufficient to produce all the phænomena he names as impoſſible to be explicated. And, firſt, for the buſineſs of expanſion, it will very naturally be explained by it. As let us ſuppoſe, for inſtance, the diameter of theſe ſmall coyled particles of the air (which being next the earth, are preſſed upon by all thoſe numerous incumbent particles, that make up the atmoſphere, and are thereby ſo crouded, that they can but very little untwiſt themſelves; let us ſuppoſe, I ſay, the diameter of theſe particles to be $\frac{1}{1000000000000}$ of an inch; and then to be much of the form of thoſe repreſented in the 4th figure by A B C D: and that theſe particles, when a conſiderable quantity of the preſſure of the ambient parts is taken away, will fly abroad into a coyle or zone ten times as big in diameter as before; that is, they will now be $\frac{10}{1000000000000}$ of an inch in diameter, and appear in the form of thoſe in the figure expreſſed by E F G H. Theſe zones, whirled round as the former, will deſcribe a ſphere 1000 times as big in bulk, and thereby fence that ſpace from being entered by any of the like zones. This it would do, ſuppoſing thoſe ſpheres did immediately always touch each other; but becauſe of their circular motion, whenever they meet, they muſt neceſſarily be beaten, and fly off from one another, and ſo require a yet greater ſpace to perform their motion in. This ſuppoſed, there are no phænomena of rarefaction, (which is enough at preſent to anſwer what he objects) but may be naturally and intelligibly made out. As firſt, for that of the ſwelling of a carp's bladder, if we ſuppoſe ſome ſmall parcels of the former compreſſed *laminæ* to lie latitant within the folds of it, and being much coyled up together ſcarce to take any ſenſible room, this bladder in the air will appear to contain very little or nothing within it; whereas when the preſſure of the air is taken off in good part from the outſides of it, then thoſe formerly latitant particles diſcloſe themſelves by flying open into much bigger zones, ſo as perhaps to be able to defend a thouſand times bigger ſpace from being entered into by their like or any other groſs particles, ſuch as thoſe of the bladder. Now becauſe the pores of a bladder are ſuch as are not eaſily permeable by the particles of air, therefore theſe lurking particles ſo expanding themſelves muſt neceſſarily plump out the ſides of the bladder, and ſo keep them turgid, until the preſſure of the air, that at firſt coyled them, be re-admitted to do the ſame thing for them again.

NEXT, as for rarefaction by heat, that will as naturally follow as the former from this hypotheſis. For the atoms of fire flowing in, in great numbers, and paſſing through with a very rapid motion, muſt needs accelerate the motion of theſe particles; from which acceleration their ſpring, or endeavour outward, will be augmented; that is, thoſe zones will have a ſtrong nitency to fly wider open, (for we know, that the ſwifter any body is moved circularly, the more do the parts of it endeavour to recede from the center of that motion,) from whence, if it has room, will follow a rarefaction. As for the conveyance of light, that being, according to *Epicurus*, performed by the local motion of peculiar atoms, their motions to and fro through this medium will be leſs impeded by the rarefied air than by the condenſed; as indeed upon experiment we ſhall really find them.

As for his third objection, drawn from his ſuppoſed attractive virtue of the thus-rarefied air, that is quickly anſwered, by denying it to have any power at all of attraction; and by ſhewing (which is already done) that what effects he would have to be performed by the attraction of the included, are really done by the preſſure of the ambient air.

AND, laſtly, the phænomena of my Lord *Bacon*'s experiment are ſufficiently obvious, and eaſy to be deduced.

So then, by granting *Epicurus* his principles, that the atoms or particles of bodies have an innate motion; and granting our ſuppoſition of the determinate motion and figure of the aërial particles, all the phænomena of rarefaction and condenſation, of light, ſound, heat, *&c.* will naturally and neceſſarily follow: and the author's objections againſt this firſt way of rarefaction will ſignify very little.

As to the ſecond way of rarefaction by the intruſion or intervention of ſome ſubtile matter or æther, into the ſpaces deſerted by the rarefying particles, which is that propoſed by the aſſertors

aſſertors of a *Plenum*, this alſo is by the author condemned, and branded with impoſſibility. And why? firſt, becauſe 'tis (he ſays) impoſſible, that the above-mentioned phænomena of the carp's bladder can be explained by it. Secondly, becauſe it is impoſſible to give a reaſon from it of the impetuous aſcent of water admitted into an exhauſted receiver. And, thirdly, becauſe it is impoſſible to explicate the phænomena of gun-powder. His reaſons to confirm which three impoſſibilities, becauſe drawn from a mere miſtake, or ignorance of thoſe hypotheſes which have been invented by the aſſertors of that opinion, I ſhall paſs over, and content my ſelf to explain a way how theſe impoſſibilities may become poſſibilities, if not probabilities.

AND the way, that I ſhall take, ſhall be that of the moſt acute modern philoſopher Monſieur *Des Cartes*, publiſhed in his Philoſophical Works: which is this, That the air is a body conſiſting of long, ſlender, flexible particles, agitated or whirled round by the rapid motion of the *globuli cæleſtes*, and the ſubtile matter of his firſt element, whereby they are each of them enabled to drive or force out of their vortice all ſuch other agitated particles. Now the ſwifter theſe bodies are whirled round, the more do their flexible parts fly aſunder and ſtretch themſelves out, and the more forcibly do they reſiſt the ingreſs of any other ſo agitated particles into their vortice; and conſequently the ſlower their motion is, the leſs will be their reſiſtance. And becauſe there is a vaſt number of theſe whirled particles lying one above another, and each particle having its peculiar gravity; it will neceſſarily follow, that the undermoſt (which to maintain their vortice muſt reſiſt ſo great a preſſure) muſt very much be hindered from expanding themſelves ſo far as otherwiſe they would, were there none of thoſe incompaſſing agitated particles, that lay in their way: and that thoſe being by any means removed, or they themſelves by a more rapid motion of the particles of their vehicles, the firſt and ſecond element, (which is according to that hypotheſis an effect of heat) more ſwiftly and ſtrongly whirled round, they preſently begin to expand themſelves, and maintain a bigger vortice than before. Now to perform what I juſt now promiſed, I ſhall endeavour to give a poſſible, if not a probable, cauſe of the objected phænomena. And, firſt, for that of the carp's bladder, where the air is rarefied (ſays the author) 1000 times, it will eaſily be explained by ſuppoſing the few particles of the air, which (whilſt they ſuſtain the preſſure of all the incumbent atmoſphere) inconſpicuouſly lurk within the bladder, (each of them being able to maintain but a very ſmall vortice) to be by the ſubſiding mercury in the Torricellian experiment freed from the preſſure of the air, and their motion continuing the ſame (by reaſon that the tranſcurſion of their vehicles is not at all, or very little, hindered either by the glaſs or bladder) their parts having room to expand themſelves, will fly abroad to ſuch extenſions, as may perhaps make a vortice 1000 times as big in bulk as what they were not able juſt before to exceed. Hence the particles of the air (being ſo groſs as not eaſily to pervade the pores of the bladder) muſt neceſſarily drive out the ſides of the bladder to its utmoſt extent, and ſerve to fill the receiver in the Magdeburgick experiment. Now, whereas theſe particles will by the ſame preſſure of the air be reduced to the ſame ſtate they were in at firſt, that is, to be thronged into a very little room, and thereby be able to maintain a very ſmall vortice; the air let in, in the Torricellian experiment, reduces the air in the bladder to its former inconſpicuouſneſs, as the admiſſion of the water in the *Magdeburg* experiment does that receiver full of rarefied air into the bigneſs of a hazel-nut. Now the water in this laſt-mentioned experiment enters with a great impetuoſity, becauſe driven on with the whole preſſure of the atmoſphere, and reſiſted only by the ſmall force of the ſo-far-rarefied air.

As for the author's objection againſt this way of rarefaction drawn from the phænomena of gun-powder, I ſhall endeavour to anſwer it by ſhewing them poſſibly explicable by a Carteſian hypotheſis. For ſuppoſing thoſe terreſtrial parts of the gun-powder to be firſt at reſt, and afterwards agitated by the rapid motion of its firſt element, there will be ſufficient difference of the former and latter condition in reſpect of extenſion; and ſuppoſing the particular conſtitution of gun-powder (ariſing partly from the ſpecifick forms of the particles of its ingredients, nitre, ſulphur and charcoal, and partly from their proportionate commiſtion) to be ſuch as will readily yield to the motion of his *materia ſubtilis*, ſo ſoon as an ingreſs is admitted to it by the firing of any particular parcel of it, the expanſion will be ſpeedy enough.

So then let us ſuppoſe a barrel of gun-powder placed in ſome cloſe room, to ſome grains of which we will ſuppoſe ſome actual fire to be applied, by which actual fire (the texture of the powder being ſuch) thoſe grains are ſuddenly fired; that is, many millions of parts, which before lay ſtill and at reſt, are by the action of the burning-coals ſhattered, as it were, and put into a poſture ready to be agitated by the rapid motion of the *materia ſubtilis*: into which poſture they are no ſooner put, than agitated and whirled ſufficiently by it; whence follows a vaſt expanſion of that part of gun-powder ſo fired. For each of its parts being thus whirled and hurried round, expel and beat off with great violence all the contiguous particles, ſo as that each particle takes up now 1000 times as much elbow-room (if I may ſo ſpeak) as juſt before ſerved its turn; and conſequently thoſe that are outermoſt, take every one their way directly from the parcel or corn they had lain quiet in, being hurried away by the ſudden expanſion of the particles that lay next within them: ſo that whatever grain or parcel of gun-powder they chance to meet with, before they have loſt their motion, they preſently ſhiver, and put into ſuch a motion, as makes them fit to receive the action of the

materia

materia ſubtilis. Which ſubtile matter being every where preſent, and nothing ſlow in performing its office, immediately agitates thoſe alſo like the former; ſo that in a trice the particles of the whole barrel of gun-powder are thus diſordered, and by the motion the *materia ſubtilis* muſt needs be hurried away with ſo great an impetuoſity on all ſides, as not only to break in pieces its ſlight wooden priſon, and remove the lighter particles of the ambient air, but huge beams, nay, vaſt accumulated maſſes of the moſt compacted ſtructures of ſtone, and even ſhake the very earth itſelf, or whatever elſe ſtands in its way; whoſe texture is ſo cloſe, as not to give its particles free paſſage through its pores. This underſtood, I ſee not, firſt, what the author's three arguments, brought to prove his objection, ſignify; for there are no more corpuſcles in the room before the gun-powder is fired than after, nor is there any more matter or ſubſtance, before the ſides of the room, by yielding, give place for the external fluid bodies to ſucceed, and the only change is this, that the *globuli ſecundi elementi* (as he calls them) are expelled out of the room, and the *materia primi elementi* ſucceeds in the place of it. Nor do I ſee, ſecondly, what great reaſon he had for his grand concluſion, *Hæc abundè demonſtrant, rarefactionem per hujuſmodi corpuſcula nullatenus poſſe explicari.*

HAVING thus examined the author's firſt arguments, that rarefaction cannot be made out by any other way than his; we ſhall find his other, which he brings to eſtabliſh his own hypotheſis, much of the ſame kind. As, firſt, that his way of rarefaction implies no contradiction: for if the affirming a body to be really and totally in this place, and at the ſame time to be really and wholly in another, that is, to be in this place, and not to be in this place, be not a contradiction, I know not what is. Next, that ſome learned ſchoolmen have thought ſo; to which I anſwer, more learned men have thought otherwiſe. And, laſtly, that there are very plain examples of the like nature to be found in other things; of which he only brings one, *viz.* that of the *Rota Ariſtotelica*, which upon examination we ſhall find to make as little to the purpoſe as any of the other.

An Explication of the Rota Ariſtotelica.

THE great problem of the *Rota Ariſtotelica*, by his explication of which he pretends, not only to ſolve all the difficulties concerning local motion, *quæ philoſophorum ingenia hactenus valde exercuerunt*, but to give an inſtance for the confirmation of his unintelligible hypotheſis of rarefaction, wherein there is *extenſio ſeu correſpondentia ejuſdem rei ad locum nunc majorem, nunc minorem*; we may upon examination find to be either a paralogiſm, or elſe nothing but what thoſe philoſophers ſaid, whom he accounts gravelled with it. Of this ſubject he begins in his 25th chapter, where, after he has ſet down a deſcription of it, he makes an inſtance in a cart-wheel; *Rem ante oculos ponit rota alicujus currus, ejuſque umbo ſeu lignum illud craſſum & rotundum, cui infiguntur radii; ſiquidem dum progrediente curru ipſa rota circumducta deſcribit in ſubjecta terra orbitam ſibi æqualem, umbo ille deſcribit in ſubjecto aëre orbitam* (I ſuppoſe both here and before he means *lineam*) *ſe multo longiorem, utpote æqualem orbitæ totius rotæ, licet ipſe non niſi ſemel quoque fuerit circumvolutus.* (As for what he ſays, that the nave muſt be ſuppoſed to paſs through the air, and not to touch a ſolid plain, I do not yet underſtand the force of his reaſon, nor why he ſets it down, making nothing to his preſent purpoſe, unleſs it were becauſe he did not well underſtand the thing.) In which, ſays he, the great difficulty is to explain how the nave ſhould be ſo turned about its axis, *ut partes ſuas ſucceſſivè applicet lineæ duplo plures partes habenti, idque motu perpetuo ac uniformi nè vel ad oculum inſtar interrupto.* Which how true, and what great occaſion he had to wonder at the ſolution of that problem by the example of a man ſtanding ſtill and another walking, we ſhall find by and by, when we come to explain the problem: but firſt I ſhall examine his hypotheſis and explication. And firſt, he ſuppoſes time to conſiſt of a determinate number of indiviſibles, (that is, ſuch as have neither *prius* nor *poſterius* included in them) which he calls inſtants. And next he ſuppoſes the *præſentiam localem ſeu ubicationem cujuſlibet partis indiviſibilis & virtualiter extenſæ eſſe quoque indiviſibilem & virtualiter extenſam.* Which ſuppoſition, ſo ſtrangely expreſſed, is no more than this; that the extenſion or ſpace of his indiviſibles is alſo indiviſible. But as for his virtual extenſion, I confeſs I underſtand as little what it is, as I verily believe he did: and therefore I will proceed to his following ſuppoſition. His third therefore is, that by how much more rare a body is, by ſo much the more are its indiviſibles virtually extended. Hence his fourth is, that though theſe indiviſibles be really indiviſible, yet they are virtually *in quotvis partes diviſibiles.* Whence he deduces his fifth principle, that ſince theſe indiviſibles are really indiviſible and virtually extended, they muſt neceſſarily be moved after the ſame manner that other indiviſible and virtually-extended things are. His inſtances are in the motions of an angel and an indiviſible piece of wood, which, he ſays, are both of the ſame kind. As for that of angels, having no immediate revelation, and a ſpirit and its actions not falling under ſenſe, and not having any third way by which to be informed, I ſhall leave him there to enjoy his fancies. But as for that of his piece of wood, we ſhall find it ſufficiently full of abſurdities and contradictions. And firſt, he calls it indiviſible, but why I know not, for it is neither really nor yet mentally ſo: not mentally ſo, by his fourth principle, where he ſays that it is *virtualiter in quotvis partes diviſibiles*, by which word *virtualiter* he means the ſame thing with *mentaliter*, or nothing. Nor, ſecondly, is it really ſo: for then (according to the main buſineſs of his book, as may be gathered from the firſt words of his title-page, *Tractatus de corporum inſeparabilitate*) it would be impoſſible, that any

thing

thing in the world ſhould be diviſible; for he making an inſeparable continuity, and that bodies will rather be (I cannot tell how) ſtretched beyond their own dimenſion *in infinitum*, than part from one another; a body may as ſoon paſs through the dimenſions of any one indiviſible, as paſs between two. Next, he grants in the ſtrange ſtretching or rarefaction of theſe indiviſibles a temporary motion of the condenſed dimenſion; whence there will follow, that there muſt be diſtinct places or *ubi's*, it muſt be *terminus à quo*, *terminus ad quem*, & *medium*. And next, it were impoſſible to divide a line into two parts, ſuppoſing it conſiſted of an unequal number of indiviſibles; as if 101 indiviſibles of exceedingly-rarefied air ſhould be extended in length an inch, it were impoſſible to divide that inch into two equal parts. I might run over many more, but it would be too tedious to be here recited. As for his indiviſible parts of time, thoſe alſo muſt neceſſarily be *in quotvis partes diviſibiles*; for elſe the ſame body or indiviſible muſt neceſſarily be in divers places at the ſame inſtant. But becauſe he can ſwallow, nay confidently affirm, this and many other ſuch like contradictions and abſurdities, I am not willing to mention them; and I think it would have made more for the author's reputation, if he had done ſo too. As for his laſt chapter, where he applies theſe principles to the explication of the *Rota Ariſtotelica*, I have not here time to ſet down all the abſurdities, that any one that has but a ſmattering in the mathematicks may obſerve: as, ſometimes half an indiviſible part of a circumference may touch an indiviſible of a line, ſometimes one may touch half, a quarter, a hundredth part, a whole one, two, ten, a hundred, &c. at the ſame inſtant; nay, an indiviſible of a circle may be all of it in a thouſand places together, and the like. And this he brings as a great argument to eſtabliſh his hypotheſis of rarefaction, pretending it to compriſe many ænigma's and very great difficulties; whereas the thing is very plain and eaſy, and contains no ſuch obſcurities. For if, for example, we ſuppoſe a wheel A B C D to be moved in a direct motion from A I C to K L M, every point of it retaining the ſame poſition to that line, that they had at the beginning of their motion, each of the points A E I G C will on a plain, or in the medium it pervades, paſs through or deſcribe a line equal to the line I L, and not only all the points lying in the line A I C, but all and every point of the whole area of the circle: this muſt neceſſarily happen, if the diameter A I C be moved parallel to itſelf: but if whilſt it be thus moved with an equal progreſſion, it be likewiſe moved with an equal circulation, the caſe will be altered. For then, firſt, each point will by this compound motion deſcribe on the plain or medium either a perfect cycloid, as when the wheel makes one perfect revolution, whilſt the whole is progreſſively moved from I to L; or ſome piece, as when the wheel has not perfected its revolution; or more than a whole one, as when the circle has made more than one whole revolution, whilſt it is moved in its determinate length. I ſhall here only conſider the firſt, as pertaining more eſpecially to my preſent purpoſe, and in regard the two latter on occaſion may be eaſily explicated by it. Next, each point of this circle acquires from its compounded motion various degrees of celerity as to its progreſſion, according to its various poſition to a point, which is always found in ſome part of the line drawn through the centre of the circular motion perpendicular to the progreſſive. And it is found thus, As the circumference to the radius, ſo is the line of the progreſſive motion to the diſtance of the point from the centre. And this happens, becauſe the line of progreſſion is equal to the circle deſcribed on that diſtance as radius; each point therefore of this ſmaller circle, when it comes to touch the perpendicular, muſt, as to its progreſſive motion, ſtand ſtill: this point therefore will be the centre of this compounded motion. Now becauſe for the explication of the *Rota Ariſtotelica* we need not conſider any other than thoſe points, which are tranſient through or croſs the perpendicular line, we ſhall only examine them. Let then in our example A be the centre or immoveable point; the circumference therefore A B C D will be equal to I L or A K by our hypotheſis. Now becauſe the point I, which is the centre of the rotation, has only one motion, *viz.* that of lation, its celerity will be equal to the ſingle celerity of the lation; we will therefore put it to have one degree C, becauſe it is moved with two motions, both tending the ſame way, and each equal to the velocity of I, muſt needs have two degrees of velocity. The point F, becauſe moved with two motions, both tending the ſame way, the one (*viz.* its lation) being equal to that of I, and the other (becauſe it is but half as far diſtant from the centre of rotation as C, and therefore is moved but with half the celerity of C, which was equal to that of I) but half as quick, we will put to have one degree and an half. By the like method we might find the velocity of all the points in the perpendicular, *viz.* ſuch as we have there marked ſome of them; but it would be too tedious, we needing not to conſider more than the two points A and E. The point at E being moved forward by its progreſſion with the ſame velocity that I, but by its rotation (which is but half as ſwift as that of the circle A B C D that is double the circle E F G H) being moved the contrary way or backwards with half the velocity, loſeth half of its progreſſion forwards. The point in A being by its progreſſion moved forwards equally ſwift with I, and by its rotation (the circle A B C D being equal to the line I L) being carried backwards with equal velocity, muſt neceſſarily ſtand ſtill as to its progreſſion. Now having ſhewn, that the point A (being by reaſon of its two equal oppoſite motions at reſt) does only touch a point of the line A K, and is not at all moved on it; and that the point E (being carried forward twice as faſt by its progreſſion as it is carried backward by its rotation, and thereby moved half as faſt as the point I) does not only touch the line E K, but whilſt it touches it, is moved on it with a progreſſive motion half as ſwift as that

of I: it will neceſſarily follow, that each point ſituate in E muſt neceſſarily deſcribe a ſmall line, which is a part of the whole E C. Now both the contact of the former, and the contact and progreſſion of the later, being performed by an infinite ſucceſſion of points in the ſpace of an infinite ſucceſſion of inſtants; I ſee not any one difficulty of this problem, but may ſatisfactorily be given an account of by it, without having recourſe to the hypotheſis of the determinate number of indiviſibles of ſpace and time, which at beſt will only come to this, that *in ſuch a determinate moment or minute ſpace of time*, (which conſiſts of an infinite conſecution of inſtants, and has *prius* and *poſterius* in it; though yet he will call it an inſtant, and have it to have the ſame proprieties with an inſtant uſed in the common philoſophical ſenſe) *ſuch a determinate minute corpuſcle* (which though it have extenſion in length, breadth and thickneſs, yet will he not admit it to be diviſible or have parts, no not though, according to his hypotheſis, the indiviſible of one body may be rarefied to be as big in bulk as a million of the indiviſibles of another, but will have it to be called and to be a real indiviſible) *will ſucceſſively paſs over ſuch a determinate ſpace or length*, (which yet he will not admit to be diviſible, though according to his principles it may equalize the length of millions of his other indiviſibles, nor admit a ſucceſſive motion, but inſtantaneous, though that does neceſſarily put a body into two, three, ten, a hundred, *&c.* places at once; but will have theſe alſo to be indiviſible.) Haſte makes me paſs over the abſurdities about the contact of a circle and a line, and to compriſe in ſhort all that great explication he has given of this and other intricate (as he calls them) problems; which is this, that the reaſon of the celerity of the motion of ſome one of theſe indiviſibles above another is, that it paſſes through a greater part of an indiviſible in the ſame inſtant than the ſlower; that is, in plain ſenſe, no more than this, One body is ſwifter than another becauſe it is moved faſter. From whence he draws ſeveral corollaries, as that, Hence may be given a reaſon, why an eagle is ſwifter than a tortoiſe, *viz.* becauſe it moves faſter. I ſhould have ſolved ſeveral objections, which maybe brought againſt the diviſibility of quantity *in infinitum*; but that as all the ſcholaſtick writers are full of them, ſo it is a ſubject, which we are leaſt able to diſpute of, having very little information of the nature of infinity from the ſenſes.

A N

E X A M E N

OF

Mr. *T. HOBBES* his

Dialogus Phyſicus de Natura Aeris;

As far as it concerns Mr. *BOYLE*'s Book of New Experiments touching the SPRING of the AIR, *&c.*

With an APPENDIX touching Mr. *HOBBES*'s Doctrine of Fluidity and Firmneſs.

The PREFACE.

HAVING, ſoon after I had begun the following examen of Mr. *Hobbes*'s dialogue, been diverted for a good while by divers urgent avocations from purſuing it; I was in the mean time informed by learned men, (ſome of whom keep great correſpondences with the virtuoſi abroad) that my publiſhing any thing againſt his objections would not be neceſſary, nor was much expected. Whereupon I ſhould perhaps have declined reſuming an employment, that to a perſon of my humour could not be delightful; but that beſides thoſe inducements mentioned at the beginning of the following treatiſe, it came into my mind, that my adverſary, not content to fall upon the explications of my experiments, has (by an attempt, for aught I know, unexampled) endeavoured to diſparage unobvious experiments themſelves, and to diſcourage others from making them. Which if he could by his

dialogue

dialogue effect, I dare be bold to ſay. he would far more prejudice philoſophy by this one tract, than he (and that it may not ſeem ſaid to undervalue him, I ſhall add, or any man elſe) can promote it by all his other writings. Wherefore, though his diſparaging of experiments would probably have much more authority (eſpecially with conſidering men) if he had been the author of conſiderable ones, or did appear to be more than ordinarily ſkilled in them: yet leſt, for all this, his fame and confident way of writing might prejudice experimental philoſophy in the minds of thoſe, who are yet ſtrangers to it, I thought it might not be amiſs, both to go on with the diſcourſe I had begun, and to enlarge it beyond what I firſt deſigned; and accordingly, to the intended vindication of the main points of our doctrine, *the weight and ſpring of the air*, which (if I miſtake not) we have firmly eſtabliſhed, we have added an Examen, that otherwiſe we ſhould ſcarce have made, of the greateſt part of the phyſiological paſſages in Mr. *Hobbes*'s book, moſt of which I thought might be rationally queſtioned, and many of them clearly diſproved. And in purſuance of this, though I did not perhaps always think myſelf obliged to proſecute things further than the nature of my deſign required, or to forget, that the matters in diſpute were not all of an equal weight; yet the reflections I have employed will, I preſume, be found ſufficient to ſhew, both that it is eaſy even for a great wit frequently enough to miſtake, and much more frequently to miſs of clearly demonſtrating what he pretends in matters phyſical, for want of having ſufficiently conſidered the experiments he would be thought to deſpiſe; and that Mr. *Hobbes*'s adverſaries need not be much aſhamed of the name he is pleaſed to give them, of experimentarian philoſophers. It was alſo ſuggeſted to me, that the dangerous opinions about ſome important, if not fundamental, articles of religion, I had met with in his *Leviathan*, and ſome other of his writings, having made but too great impreſſions upon divers perſons, (who, though ſaid to be for the moſt part either of greater quality, or of greater wit than learning, do yet divers of them deſerve better principles,) theſe errors being chiefly recommended by the opinion they had of Mr. *Hobbes*'s demonſtrative way of philoſophy; it might poſſibly prove ſome ſervice to higher truths than thoſe in controverſy between him and me, to ſhew, that in the Phyſicks themſelves, his opinions, and even his ratiocinations, have no ſuch great advantage over thoſe, of ſome orthodox Chriſtian Naturaliſts. But for all this, as little as I could grudge to write a much longer than the following diſcourſe to do religion the leaſt ſervice; yet thinking it fit to leave controverſies of this kind to thoſe, whom they more particularly concern, I ſhould ſcarce, in the introduction to a diſpute about the air, have at all mentioned any thing of this nature, but that Mr. *Hobbes*, in the preface to his dialogue, is pleaſed (though I know not to what purpoſe in that place) to ſpeak without limitation or diſtinction (and conſequently unwarily enough at leaſt) of the things ſaid in the books of naturaliſts concerning immaterial ſubſtances, (and ſure ſome things true, at leaſt that there are ſuch beings, as well as ſome things erroneous, are there ſaid;) though he hath been, by the learned Dr. *More*, and others, publickly accuſed to have taught, that it is abſurd to believe, that there either are or can be any. Which yet, methinks, he could not do, ſince elſewhere, and in this very dialogue, he builds ſeveral things in his * philoſophy upon the creation of the world, and an infinite power: And how a thing material can create matter, and have an infinite power, I confeſs I do not underſtand.

I DOUBT not but critical readers will think I might have excepted againſt many more particulars in Mr. *Hobbes*'s book than I have examined; and indeed, about this, I dare not contend with them. For beſides that I may, through haſte and indiſpoſedneſs to quarrel, have over-ſeen ſeveral things, which an eye either ſeverer or more attentive would have obſerved; I purpoſely paſt by divers things I did not altogether over-look; partly, becauſe I thought it needleſs to queſtion them, (having no want of other objections) and partly, becauſe I could not do ſo in few words, and was loth to engage in needleſs and long-winded diſputes: and, perhaps, I was too weary of my employment, to be willing to ſpend many words, when I could ſafely ſpare them. And though others will poſſibly think it ſtrange, that a member of the ſociety he is ſo ſevere to ſhould not take notice of ſuch paſſags as theſe; *Nam conveniant* (ſays he, ſpeaking of the virtuoſi, that meet at *Greſham* college) *ſtudia conferant, experimenta faciant quantum volunt, niſi & principiis utantur meis, nihil proficient.* And again, *Næ illi quæ dicerent non videntur cogitaſſe, ſed ſortitos eſſe.* And elſewhere, *Conjicere hinc licet, quam ſint boni ratiocinatores, & quæ ſit ab illis expectanda philoſophia naturalis.* And (to trouble you no more) *Ad cauſas autem, propter quas proficere ne paululum quidem potuiſtis nec poteritis, accedunt etiam alia, ut odium Hobbii, quia nimium liberè ſcripſerat de academiis veritatem: nam ex eo tempore irati phyſici & mathematici veritatem ab eo venientem non recepturos ſe palam profeſſi ſunt*; though, as I ſaid, ſome may wonder I ſhould ſilently pretermit ſuch paſſages as theſe; yet beſides what I elſewhere ſay by way of account of my ſo doing, I ſhall here tell them, that I preſume ſome ſorts of readers will more eaſily pardon me for neglecting ſuch expreſſions, than they will Mr. *Hobbes* for uſing them. And I confeſs, I thought I ſhould find it more eaſy to ſay nothing at all to ſuch paſſages, than ſay any thing without ſaying ſomewhat, that would offend a perſon, that could allow himſelf to ſay ſuch things. Though I ignore not, that divers readers will much the leſs reliſh the following diſcourſe, for my having, perchance not altogether for want of

* —*Neque hominis philoſophi eſſe cenſeo corporum quorundam, ut ſolis & ſtellarum, mirabiles ſupponere magnitudines, contra vero mirabiles exiguitates non admittere, cùm virtutis ejuſdem infinitæ ſit utraque creare tam maxima quam minima.* Mr. *Hobbes* in his Dialogue of the Air, page 11. See alſo page 5. and elſewhere.

of knowing how to write otherwiſe, forborn to furniſh it with quick and ſmart expreſſions, which are wont to be employed in diſputes, to expoſe or depreciate an adverſary's perſon or cauſe, and which are uſually not the leaſt things, that ſerve to amuſe ſuch readers, and engage their attention. But I fear I have much leſs need to make excuſes for my omiſſions, than for having, in the following examen, been reduced by the nature of my taſk, to ſay ſo many things, which intelligent readers need not be taught by me. And therefore ſuch ſhall have my conſent to ſkip, if they pleaſe, the whole diſcourſe: which though I could ſcarce upon ſuch an occaſion make a very inſtructive one; yet if they will be pleaſed to forgive me its barrenneſs, I hope hereafter to avoid the like temptations of writing again at the like rate.

AND having ſaid thus much as to the reaſons of my penning the following diſcourſe, I muſt add ſomething, though but little, touching the manner of it; wherein I hope I have not much, if at all, ſwerved from what I propoſed to myſelf; namely, to give an example of diſputing in print againſt a provoking, though unprovoked, adverſary, without bitterneſs and incivility, and without purſuing thoſe things, which how much more ſoever they belong to the perſon of an antagoniſt than to his cauſe, are wont to make up a great part (if not the greateſt) of books divulged on ſuch occaſions. But ſince I intend what I write for intelligent and ingenious readers, I dare expect, that my forbearing to inſiſt on ſuch things, as I judged wholly extrinſical to the opinions and arguments I examine, will be aſcribed to the true cauſe, that my diſcourſe will not be thought to have the leſs of reaſon for having the leſs of paſſion; and (eſpecially) that my ſilence as to thoſe things, that are ſpoken to the diſparagement of the illuſtrious company, that meets at *Greſham* College, will be looked upon only as an effect of my judging it fit to leave them the full liberty to right themſelves, if they think it worth while, by ſome better pen than mine. And if Mr. *Hobbes* thinks fit to ſay any thing to the following diſcourſe, it will not be amiſs, that his reply be as inoffenſive as I have endeavoured to make my examen. For having diſpatched as much as I think requiſite to ſay of this controverſy myſelf, and having other (and I hope better) employments for my leiſure hours, if I can get any; I muſt leave the further diſputes, if any ſhall ariſe, to be managed by others, who, if Mr. *Hobbes* refuſe to imitate my way of writing, will poſſibly make no ſcruple to imitate his, and put him in mind of that law of *Veſpaſian*, upon which himſelf would be thought to ground that heap of ſtrange titles he beſtows upon the two learned *Savilian* Profeſſors *, *That it is unlawful to give ill language firſt, but civil and lawful to return it.* I have but one thing more to add; which is, that I would not be ſo far miſtaken, as to be, upon the account of what I have written againſt my two adverſaries, looked upon as a perſon wedded to his opinions: for not having hitherto learned, that either of their books has yet made proſelytes; I preſume it will not be wondered at, that they have not made me one. And though the two learned authors I have anſwered, have given me no cauſe to retract any of my opinions; yet as it is not improbable, that others reaſoning upon better principles may do what theſe have not done, ſo I am ſtill of the ſame temper I was of, when I uſed to propoſe my thoughts but as conjectures.

A N

EXAMEN

Of the greateſt part of Mr. *HOBBES*'s

Dialogus Phyſicus de Natura Aeris.

CHAP. I.

The occaſion and ſcope of the preſent treatiſe.

MEETING the other day with a treatiſe then newly publiſhed by Mr. *Hobbes*, and intitled *Dialogus phyſicus de naturâ aëris*; the name of the author, the ſubject of the book, and the information I had a good while before received from his friends, that he was writing againſt me, invited me to peruſe it, as a diſcourſe, wherein I might probably find myſelf concerned: nor was I deceived in my expectation. For having curſorily paſſed through it, I readily found, that though I be not expreſly named there, and though ſome things in the title-page, and ſome others in the book itſelf, ſeem to make the chief deſign of it to be the diſparagement of the ſociety, that is wont to meet at *Greſham* College; yet the arguments are for the moſt part levelled at ſome writings of mine, publiſhed, ſome of them, the year before, and ſome of them this laſt ſpring; as the Experiments, whoſe explications he is pleaſed to cenſure, do all along declare. I confeſs

* So go your ways (ſpeaking to Doctor *J. Wallis* and Doctor *S. Ward*) you uncivil eccleſiaſticks, inhumane divines, dedoctors of morality, unaſinous collegues, egregious pair of *Iſſachars*, moſt wretched *Vindices* and *Indices Academiarum*; and remember *Veſpaſian*'s Law, &c. Mr. *Hobbes*'s Leſſon 6. p. 64.

confeſs I was ſomewhat ſurprized to find, that Mr. *Hobbes*, whom if my books have at all mentioned, it has been with reſpect, ſhould fall upon a perſon, that had not provoked him; whilſt ſuch mathematicians as Dr. *Wallis*, Dr. *Ward*, *Tacquet*, and *Moranus* (men much too famous to be deſpicable adverſaries) having a good while ſince profeſſedly and unchallenged written againſt him, he hath yet the whole diſcourſes of ſome, and ſo great a part of the objections of the others, to reply to. And it ſomewhat added to my wonder, that a writer of politicks ſhould cauſeleſly and needleſly, for aught I can learn, fall upon a ſociety, whereof, beſides many other perſons of quality and men of parts, his own great patron, and my highly honoured and learned friend, the Earl of *Devonſhire* himſelf, is an illuſtrious member. And as for me, I ſhall not ſcruple to confeſs, that I could have been well enough contented Mr. *Hobbes* had ſpared this dialogue, partly becauſe I have a natural indiſpoſedneſs to contention, partly becauſe I am at preſent diſtracted by ſtore of other employments both of a publick and a private nature, (and particularly by the publiſhing of three or four books of differing ſubjects, and printed in ſeveral places;) partly becauſe Mr. *Hobbes*'s objections are of ſuch a nature, that perhaps my replies, though as ſhort as (my deſign mentioned in the preface conſidered) I can conveniently make them, will amount to a longer diſcourſe, than moſt readers will think the objections needed; and partly too, becauſe Mr. *Hobbes* is pleaſed to write of divers worthy and learned men in ſo depreciating, and of himſelf in ſo differing a way, that I fear I ſhall find it ſomewhat uneaſy to retain (under ſuch provocations to decline it) the civility I am wont, and am deſirous to write with; and that I muſt almoſt deſpair of diſſenting without an abſolute rupture from a perſon, whoſe way of diſcourſing is ſuch, that though I ſhall not give it any epithet, yet I confeſs it leaves me but little hope, that I can oppoſe him without angering him.

But however, becauſe if I can (as I intend to do) ſo far comply with my inclinations and my cuſtom, as to wave perſonal and intrinſic matters, and reſtrain myſelf to the examen of the argumentive part of his diſcourſe, my reply will not need to be prolix; and becauſe he has vouchſafed rather to ſingle out a young writer, whoſe books (at leaſt of matters philoſophical) do but begin to appear in the world, than to defend himſelf againſt thoſe illuſtrious enemies, upon whom he might expect to gain much more honour; and becauſe Mr. *Hobbes*'s name may with ſome readers give his arguments an efficacy, which their own nature could not confer on them; I muſt reſolve to ſubmit to what he and my concern for the truths he rejects impoſe upon me. But to ſhorten as much as I can a work, to which I can allow but very little time, it will be expedient, before I deſcend to the examination of particulars, to premiſe three or four advertiſements touching the occaſion and the nature of the controverſy, that I might not be reduced to a frequent and unwelcome inculcation of the ſame things.

CHAP. II.

Of ſome miſtakes of Mr. Hobbes *touching matters of fact, and the author's doctrine.*

And firſt, whereas Mr. *Hobbes* is pleaſed to write, as if the explications and experiments to be met with in the phyſico-mechanical treatiſe he cenſures, were thoſe of the whole ſociety at *Greſham* College; I muſt do them that right to declare, that this way of proceeding is manifeſtly grounded upon a miſtake. I will not affirm, that the miſtake was wilful, that Mr. *Hobbes* might give himſelf a pretence to quarrel with them, (who have hitherto ſuſpended the declaring themſelves as a Society) in the controverted points. But there are ſome, that think Mr. *Hobbes* might very eaſily have avoided this miſtake, ſince the book he cenſures was publiſhed (and perhaps taken notice of by moſt of the virtuoſi here) ſome months before the ſociety was begun. And the experiments themſelves had been, long before the book came forth, not only ſeen and diſcourſed of by divers learned men and illuſtrious perſons, but had the honour to have our great monarch of the virtuoſi, as well as of *Great Britain*, for a ſpectator. And though poſſibly divers of the learned members of our aſſembly may have no unfavourable opinion of what I have delivered in that book; yet the aſſembly, as ſuch, has been ſo far from adopting or owning my opinions as theirs, that it has with approbation been propoſed among them, to repeat the experiments, and take a review of the explications, that upon a ſtrict examen of the ſeveral opinions, and the objections that could be brought in againſt them, they might ſee, what judgment will be fit to be paſſed on them. And although there be very few philoſophers, whoſe parts may make their judgment more formidable to me; yet to comply with their deſign, whatſoever the event might be, I preſented them the engine it ſelf, I had made uſe of and deſcribed in my book; chuſing rather to undergo their cenſures, than want their inſtructions. By which it may appear, upon how little ground Mr. *Hobbes* has thought fit to impute to the ſociety thoſe opinions, which (how erroneous ſoever he is pleaſed to think them,) I muſt own to be mine. And this juſtice I the rather do it, becauſe it is all, that I am to do in this treatiſe on their behalf, not only for the reaſons above intimated, but becauſe the vindication of ſuch an aſſembly againſt Mr. *Hobbes* deſerves a better pen than mine, though it doth not need it.

Secondly, Undertaking then the defence of my own cauſe, without intereſting them in my quarrel, I muſt next admoniſh the reader, that whereas Mr. *Hobbes* writes, as if the new experiments were deviſed, or at leaſt employed, to prove a vacuum; he is in this likewiſe miſtaken. For neither has the ſociety declared either for or againſt a vacuum, nor have I: nay, I have not only forborn to profeſs my ſelf a Vacuiſt, or a *Pleniſt*, but I have in a fit place of my epiſtle expreſsly ſaid, that I reſerved the declaring of my own opinion touching that

point to another diſcourſe, (which as yet is not publiſhed.) Wherefore Mr. *Hobbes* either injures or miſtakes thoſe, whom he will needs make his adverſaries, when he repreſents the new experiments as demonſtrations alledged by profeſſed Vacuiſts to diſprove the fulneſs of the world. And though I ſhall be obliged in the following diſcourſe to reject Mr. *Hobbes*'s ſuppoſition of a plenum; yet I intend not thereby to declare, whether or no I do abſolutely allow a vacuum. But that, which I drive at, and which alone my preſent work exacts, is to ſhew, that I may reaſonably oppoſe the hypotheſis of a plenum, as it is ſtated by Mr. *Hobbes:* and conſequently, unleſs he had better proved it, I may very well refuſe to let him take it for demonſtrated. But I intend not to queſtion, whether, or no, other Pleniſts may not have better arguments than his principles have ſuggeſted to him; nor to deny but that the Carteſians may, without granting a vacuum, give a more plauſible account (whether true or no) of divers of the phænomena of our engine, if they will add, as ſome of them of late have done, the ſpring of the air to their hypotheſis, that the celeſtial matter, of which the air does in great part conſiſt, is ſubtile enough freely to paſs through the pores of the cloſeſt bodies, and even glaſs it ſelf.

As for the aſſertion *non dari vacuum*, though, as I ſaid, I need not in this place declare my ſelf either for or againſt it, yet I confeſs I do not find, that Mr. *Hobbes*, though all along this diſcourſe he argues from this principle againſt thoſe he thinks Vacuiſts, has demonſtrated it. *Cap. 26. Sect. 2.* For in his book *De corpore* (though a main part of it depends upon the plenitude of the world) he has, that I remember, but one poſitive argument (indeed he thinks that unanſwerable) to evince it. And that is drawn from this experiment: 'That if a gardener's 'watering-pot be filled with water, the hole 'at the top being ſtopped, the water will not 'flow out at any of the holes in the bottom: 'but if the finger be removed to let in the air 'above, it will run out at them all; and, as 'ſoon as the finger is applied to it again, the 'water will ſuddenly and totally be ſtayed 'again from running out. The cauſe whereof '(ſubjoins he) ſeems to be no other but this, 'that the water cannot by its natural endeavour to deſcend, drive down the air below 'it, becauſe there is no place for it to go 'into; unleſs either by thruſting away the 'next contiguous air it proceed by continual 'endeavour to the hole at the top, where it 'may enter and ſucceed in the place of the 'water that floweth out; or elſe by reſiſting 'the endeavour of the water downwards, penetrate the ſame, and paſs up through it.'

BUT this experiment, as an obvious one, and without dreaming that Mr. *Hobbes* had laid ſuch ſtreſs upon it, I have incidentally anſwered in what I ſay in two or three paſſages on the thirty-third experiment of my epiſtle; but after found, that it had been more fully anſwered (but upon grounds, ſome of which I do not need) by my learned friend Dr. *Ward*, with whom I thus take Mr. *Hobbes*'s argument to pieces. The cauſe, according to Mr. *Hobbes*, of the ſuſpenſion of the water in the veſſel is, that the water cannot thruſt away the air. 2. And it cannot thruſt that away, unleſs air ſucceed in its place. 3. But air cannot ſucceed in its place, unleſs either by getting in at the upper orifice, or at the holes that perforate the bottom. By which view of the argument it appears, that the main force of it lies in the ſecond propoſition: but neither doth he demonſtrate that, (which omiſſion might excuſe us from any further anſwer,) nor indeed do I think it true. For if the watering-pot were tall enough, what reaſon is there, why the water ſhould not run out at the holes of it? as Monſieur *Paſchall*'s experiment mentioned in my epiſtle manifeſts; that though in a glaſs-tube hermetically ſealed at one end, and ſeveral times as long as a watering-pot, the water will not fall down, yet it will, if the tube exceed two or three and thirty foot, or thereabouts. And indeed the ſuſpenſion or deſcent of the water depends upon the proportion betwixt the weight of the aqueous pillar, that tends, downwards, and the reſiſtance or preſſure of the air, that can come to bear againſt it. For as, on the one ſide, when the height of that pillar is ſo increaſed, as that it can outweigh the atmoſpherical cylinder, that oppoſes its deſcent, it will flow out till thoſe two cylinders come to an æquilibrium; ſo, on the other ſide, if inſtead of increaſing the length of the cylinder of the water, you leſſen the preſſure and reſiſtance of the air, the water will likewiſe deſcend, though the pillar be very ſhort, as I have ſhown in the nineteenth experiment; where, by withdrawing ſome of the air in the receiver, and thereby weakening its ſpring, the water, in a tube hermetically ſealed at one end, of but about four foot long, ſubſided about three foot; though that the ſpace relinquiſhed by the water was not full of air, as Mr. *Hobbes*'s argumentation requires it ſhould be, may be proved by what is there added, 'that by letting in the outward air, when the 'water was ſunk ſo low, it was immediately 'impelled up again to the higher parts of the 'tube.'

AND indeed (as I elſewhere diſcourſe) it ſeems to me a difficult matter for thoſe, that reject, as Mr. *Hobbes* juſtly does, that conceit of nature's abhorring a vacuum, and making it, as it were, her buſineſs to hinder it, to prove there can be no vacuum at all by any particular experiment. For if the fulneſs of the world be not made neceſſary, either by the nature of body in general, or by the deſign of the author of the univerſe, it can ſcarce be eaſy to prove by a particular experiment, that no human force or art can contrive a way of overcoming, at leaſt for ſome time, and as to ſome ſpace, either the gravity of fluid bodies, or whatever other quality of the air or water it is, by which the contiguity of the neighbouring parts of the world is wont to be maintained. As we ſee the water, that will not deſcend even in a tube of thirty foot, (and thereby has made men think it will never deſcend whilſt the air is not permitted to ſucceed it,) may, by *In ſome Dialogues of heat and flame.*

our

our engine, be brought to ſubſide in a tube of about a foot long. And I ſhall here add this out of my (yet unpubliſhed) Dialogues of flame and heat; that whilſt only particular experiments are brought to aſſert the impoſſibility of a vacuum, perhaps the Vacuiſts will have the advantage on their ſide. For a thouſand experiments are not of that force, to prove univerſally, that a thing cannot be effected, as one, that ſhews it may be, is to prove the contrary. And the Vacuiſts have as well as the Pleniſts ſtore of experiments on their ſide, that ſeem to favour their hypotheſis; according to which, were it true, I ſee not why they may not ſolve the objections drawn from either the aſcenſion of liquors upon ſuction, or the non-deſcenſion of liquors in watering-pots cloſed at the top, or from any of the like experiments I have yet met with, in caſe the weight and ſpring of the air be taken in to ſolve the phænomena. And the Vacuiſts will have this advantage, that if Mr. *Hobbes* ſhall ſay, that it is as lawful for him to aſſume a plenum, as for others to aſſume a vacuum; not only it may be anſwered, it is alſo as lawful for them to aſſume the contrary; and he but barely aſſuming, not proving a plenum, his doctrine will ſtill remain queſtionable. But I think I could ſay more in favour of the Vacuiſts experiments; namely, that whereas in ſome phænomena of the Torricellian experiment, and in many of thoſe of our engine, Mr. *Hobbes* proves the ſpace deſerted by the quickſilver or the air to have no vacuity, becauſe according to his ſuppoſition the world is full; and not by any ſenſible phænomena, that prove the ſpace in queſtion to be perfectly full:) for no leſs fulneſs is requiſite to the truth of his hypotheſis: the Vacuiſts on the other ſide need not go about to prove, that thoſe ſpaces are not full by their hypotheſis: but they prove it by this, that it appears by ſenſible phænomena, that the quickſilver deſerts the upper part of the tube; and that much air is pumped out of our receiver. (The firſt of which is evident to the eye; and ſo is the other too, when the pump is kept under water.) But it does not appear by the like phænomena, that the air (as Mr. *Hobbes* would have it in his elements) does ſucceed to fill, I ſay, perfectly to fill the deſerted ſpace; which alſo they will confirm hence, that in the Torricellian experiment, by inclining the tube, the relinquiſhed ſpace may be again readily filled with mercury; and if our exhauſted receiver be plunged under water, that liquor, when acceſs is given it to the cavity, violently ruſhes into it, and almoſt fills it up.

From all which it ſeems probably deducible, that it is a very hard thing, by Mr. *Hobbes*'s way of managing the controverſy, to prove, that there can be no vacuum. But as for the Carteſians more ſubtile and plauſible way of aſſerting a plenum, it concerns me not here to diſpute againſt it, or declare for it.

I Will add this, and but this, on the occaſion of Mr. *Hobbes*'s building a great part of his philoſophy upon no ſurer a ground, that we may hence learn, how little reaſon there is to blame me, as he is pleaſed to do, for making elaborate experiments; and that though (as I have elſewhere purpoſely and amply diſcourſed) obvious experiments are by no means to be deſpiſed, yet it is not ſafe in all caſes to content one's ſelf with ſuch; eſpecially when there is reaſon to ſuſpect, that the phænomenon they exhibit may proceed from more cauſes than one, and to expect, that a more artificial trial may determine, which of them is the true.

Thirdly, whereas Mr. *Hobbes* is pleaſed to find much fault with the ſociety, and me, for not aſſigning the cauſe of ſprings in general; that omiſſion ſeeming to him very unworthy of philoſophers: I anſwer, that the ſociety having hitherto, for weighty reaſons, forborn to determine the particular cauſes of things, there was no reaſon they ſhould alter their method, for experiments, that were not made or publiſhed by them or by their order. And as for me, the title of my book promiſes ſome experiments touching the ſpring of the air and its effects, not ſpeculations of the cauſes of ſprings in general. My avowed intention was candidly to communicate with the curious ſome experiments which, I thought their novelty would render acceptable to them, wherein I have the good luck not to have been miſtaken; nor can I be juſtly cenſured for not performing what I did not undertake, nor was obliged to. And perhaps Mr. *Hobbes* would more prejudice the commonwealth of learning by his ſeverity, than he has yet advantaged it by any other way, if he could obtain, that none ſhould publiſh an experiment or obſervation that cannot, by deduction from the firſt and catholick principles of philoſophy, aſſign the true cauſe of it. But when I take upon me to write, as Mr. *Hobbes* has done, elements of philoſophy, then perhaps I ſhall be able to give an account of ſprings, not much more unſatisfactory than others think his. For though he refers us to his explication given of the motion of reſtitution in his book *De corpore*; yet in the 22d chapter, and 30th ſection, which profeſſedly contains his theory of it, after having premiſed, (what rightly interpreted may be true enough,) that the cauſe of the reſtitution proceeds not from the taking away the force, by which they were compreſſed or extended (' the removing of impediments not ' having the efficacy of a cauſe,) that which follows to the end of the ſection is only this: ' The cauſe therefore of their reſtitution is ' ſome motion either of the parts of the ambient, or of the parts of the body compreſſed ' or extended. But the parts of the ambient ' have no endeavour, which contributes to their ' compreſſion or extenſion, nor to the ſetting ' them at liberty or reſtitution. It remains ' therefore, that from the time of their com' preſſion or extenſion, there be left ſome en' deavour (or motion) by which the impedi' ment being removed, every part reſumes its ' former place; that is to ſay, the whole re' ſtores it ſelf.' Now this notwithſtanding, I am ſo dull or ſo wary, that though I had met with this paſſage, and all the praiſes the author in his Dialogue gives it, yet I ſhould have made ſome ſcruple to undertake the aſſigning the

true

true cauſe of ſprings in general. For firſt, the learned *Gaſſendus*, and the Epicureans both ancient and modern, together with divers other Naturaliſts, do not admit what Mr. *Hobbes* ſuppoſes a few lines before, that 'that which is 'at reſt cannot be moved, but by a moved and 'contiguous movent.' For they think motion, or at leaſt *conatus ad motum*, an unlooſeable property, congenit to matter. And, by the way, whatever exceptions I have to this opinion, yet I am not ſatisfied with that principle of Mr. *Hobbes*, though it be the fundamental one of his philoſophy, unleſs it be more warily propoſed. For to aſſert univerſally and without exception, as he does in his Elements, that nothing can be moved but by a body contiguous and moved; I do not take to be true, nor conſiſtent with his other aſſumptions. This I elſewhere (in a diſcourſe againſt another than Mr. *Hobbes*, about the Chriſtian religion) prove more at large: but now it will ſuffice to repreſent, that Mr. *Hobbes* not only admitting, but making uſe in his philoſophy of the creation of the world, either he muſt allow, that motion is natural to ſome, if not all parts of matter; or that God put them into a motion not included in their nature. From which it will neceſſarily follow, that at leaſt ſome bodies may have motion, though it be not given them by any body contiguous and moved, as an attentive conſiderer may eaſily diſcern. But to return to the cauſe of ſprings.

SECONDLY, whereas Mr. *Hobbes* aſſumes, that the parts of the ambient have no endeavour, which contributes to their compreſſion or extenſion, nor to the ſetting of them at liberty or reſtitution; he ſays this indeed, but does not go about to prove it. And I ſhould the leſs have made this precarious aſſertion, becauſe that after the celebrated *Des Cartes* himſelf, the Carteſian philoſophers generally aſcribed the motion of reſtitution to the paſſage of a ſubtile æthereal ſubſtance (and an æther Mr. *Hobbes* alſo admits) through the pores of the ſpringy body, which ſtriving to obtain its wonted freedom of paſſage, reſtores them to the ſhape and bigneſs, from which they were forced. Nay, I ſhall have occaſion to ſhew anon, that Mr. *Hobbes* himſelf, whatever he ſays in this place, does elſewhere aſcribe a motion of their own to multitudes of terreſtrial corpuſcles. And I might add, that elſewhere he ſpeaks of the rekindling of the fire taken out of the receiver after this manner: *Quanquam vis illius motus in recipiente (ut loquimini) evacuato diminuta ſit, oppreſſa ab aëris intus commoti conſiſtentia, non tamen extinguitur; & propterea levata oppreſſione, ſatis habebit virium ad excitandum phantaſiam lucis quanquam debiliorem:* 'Although the force 'of that motion in the evacuated receiver be 'diminiſhed, being oppreſſed by the conſiſtence 'of the air moved within, yet it is not extin-'guiſhed: and therefore that oppreſſion being 'taken off, will have ſtrength enough to ex-'cite an appearance of light, though ſome-'what weaker than ordinary.' But I ſhall rather ſubjoin, that yet, thirdly, I do not think it improbable what the learned *Gaſſendus* had taught, and what Mr. *Hobbes* here teaches, that the reſtitution of bent ſprings may proceed from a certain endeavour or motion in their internal parts (left from the time of their compreſſion or extenſion) which when the impediment is removed, makes every part reſume its former place, and thereby makes the whole reſtore it ſelf. But this notwithſtanding, I feared others might be as inquiſitive as my ſelf, and might expect from him, that would undertake to ſettle a general theory of the motion of reſtitution, the clear and diſtinct explication of ſeveral phænomena, that I had met with, which are not touched, nor perhaps were, ſome of them, thought upon by Mr. *Hobbes*. As firſt, why ſuch a determinate temper of iron and ſteel is requiſite to make it elaſtical; ſo that if after having been hardened and gradually heated, it be ſuddenly cooled, at an inconvenient point of time, it will be brittle, and fit to make gravers and other rigid tools, not ſprings. Next, why bows and other elaſtical bodies, if they be kept too long bent, loſe in proceſs of time almoſt all their elaſtical power, and continue crooked. Thirdly, why, not only divers ſolid bodies as well as lead and gold, which before trial one would think as likely, as many ſpringy ones, to have their parts put into a due motion by the force that bends them, ſhould be devoid of an elaſtical power. Fourthly, what kind of motion, and what kind of texture it is, by virtue whereof, the parts of a body being for a very ſhort time put into motion, do ſome months, perhaps ſome years, retain in great part a ſmart motion, without in ſo long a time communicating it to the ambient bodies, to ſome or other of which multitudes of them are perpetually contiguous, and thereby loſing it themſelves. Why upon ſuch a bare and inartificial change made in the texture of a body, as is ſcarce at all diſcernable to the eye, it ſhould acquire a ſtrong ſpring, that it had not before, (as I have tried upon ſilver and copper, which though flexible before they were hammered, yet being beaten into thin plates obtained a notable ſpring:) and why (which may ſeem more ſtrange, upon another light change of texture) the acquired ſpring may preſently be loſt again; as I have tried in ſilver, that, chymiſts teach us, loſes nothing in the fire, which having by being hammered acquired a ſtrong ſpring, we have preſently made flexible again as before, by only heating it red-hot, without ſo much as melting it; which argues, that in ſprings texture is as well to be conſidered as motion. To theſe I might add other particulars, that I had either made or obſerved (and mention in another treatiſe) concerning ſprings; all which phænomena perhaps every one, that has read what we have lately recited out of Mr. *Hobbes*, will not preſently be able ſatisfactorily to explicate. So that I hope the equitable reader will not think it a fault, that (contenting my ſelf to propoſe the two explications of ſprings, I ſaw moſt liked among the curious; to which I ſhould have added Mr. *Hobbes*'s, if I had found it as much eſteemed) I declined engaging my ſelf in controverſies about the origin of motion, and ſuch other high ſpeculations, as, had my abilities enabled

Page 18.

me, neither my deſign exacted, nor my leiſure permitted that I ſhould proſecute. And though Mr. *Hobbes* be pleaſed to ſpeak thus of his no-
Page 8. tion concerning the reſtitution of bodies; *Sine qua hypotheſi quantuſcunque labor, ars, ſumptus, ad rerum naturalium inviſibiles cauſas inveniendas adhibetur, fruſtra erit:* 'Without which 'hypotheſis, let never ſo much labour, art, 'coſt be beſtowed for the finding out of the 'inviſible cauſes of natural things, all will be 'in vain.' Yet whether that bold aſſertion ſhould paſs for an argument, for an hyperbole, or for a compliment to himſelf, I am content to let the reader judge.

FOURTHLY, Mr. *Hobbes* in divers paſſages, wherein he diſputes againſt me, ſeems to have miſapprehended my notion of the air. For when I ſay, that the air has gravity and an elaſtical power, or that the air is, in great part, pumped out of the receiver, it is plain enough, that I take the air in the obvious acception of the word, for part of the atmoſphere, which we breathe, and wherein we move. Nor do I find, that any other of my readers do otherwiſe underſtand me. But Mr. *Hobbes* ſeems to think he has ſufficiently confuted me, if in ſome caſes he have proved (which whether he have done well or no, is not here to be examined) that there is a ſubtile ſubſtance, which he calls æther, (but which I wiſh he had better explained) in ſome places, which I take not to be filled with air; and that the æther has or has not ſome accidents, which I deny or aſcribe to the air. Whereas I deny not, but that the atmoſphere or fluid body, that ſurrounds the terraqueous globe, may, beſides the groſſer and more ſolid corpuſcles wherewith it abounds, conſiſt of a thinner matter, which for diſtinction-ſake I alſo now and then call ethereal. And therefore though I did not think my ſelf obliged to declare againſt either the atomical or the Carteſian hypotheſis, touching the nature of the air, yet I propoſed the latter too as probable, (which as it excludes a vacuum, ſo it makes the air conſiſt in great part of a celeſtial matter.) And my incidental explications of the rarefaction and condenſation of the air, together with my comparing it to a fleece of wool, ſufficiently declare, that I take it not to be a homogeneous body; and though there be air intercepted betwixt the hairs of wool, yet in caſe I ſhould prove, that a box were not ſo full of wool as before, becauſe the moſt part of the hairs had been taken out, I ſhould not think he argued well againſt me, that ſhould only prove, that the box contained as much of matter, conſiſting of air and wool together, afterwards as before. Nor do I think Mr. *Hobbes* has in divers paſſages, wherein he ſuppoſes he diſputes againſt me, much more directly contradicted what I teach concerning the air, if that word be rightly and in my ſenſe underſtood. And on this occaſion I muſt crave leave to add, that whereas he is pleaſed to intimate, that I miſrepreſent the Carteſian hypotheſis, aſcribing that to the air, which *Des Cartes* does to water; if the reader think it worth while to compare the ſummary account I give of that Hypotheſis, with what *Des Cartes* himſelf has taught in his 45th, 46th, and 47th articles of the fourth part of his Principles, wherein that author compriſes his doctrine of the nature of the air; he will quickly find, that whether or no Mr. *Hobbes* be miſtaken, I am not, unleſs it be in eſtimating his hypotheſis by what he teaches in his principles, which were publiſhed after his meteors, and more elaborately written. And as for that particular, which alone Mr. *Hobbes* alledges, namely, that he makes not the parts of air but of water ſo flexible; *Des Cartes*'s words in the 46th article are theſe: *Cum ejus particulæ ferè omnes ſint flexiles inſtar mollium plumularum vel tenuium funiculorum, &c.* 'Seeing almoſt all its parts are flexile, like 'little ſoft feathers to fine threads.' And as for what Mr. *Hobbes* ſubjoins, *Sed quiſquis talis ſuppoſitionis author fuit, parum refert. Nam ipſa hypotheſis, in quo motus ſupponitur materiæ ſubtilis ſine cauſa velociſſimus, & præterea corpuſculorum innumerabiles vertigines diverſæ ab illius materiæ unico motu generatæ, vix ſani hominis eſt.* 'But it matters not, who was the au-'thor of that ſuppoſition. For the very hy-'potheſis itſelf, wherein is ſuppoſed a motion 'of ſubtile matter, which is ſwift without any 'cauſe aſſigned, and hath moreover divers in-'numerable circulations of corpuſcles generated 'from the ſingle motion of that marter, is not 'the conceit of a man of wit or ſenſe.' I cannot but in gratitude to ſuch a perſonage declare my diſlike, to find him upon ſo ſlight an occaſion ſo coarſely uſed for an opinion the cenſurer of it does no better confute, and which is thought to be in ſome particulars not ſo unlike his own. And perhaps I ſhould be afraid, that Mr. *Hobbes*'s ſpeaking ſo ſeverely of one, that was at leaſt a famous geometrician, might reflect upon the Engliſh civility in the opinion of ſtrangers, if I did not hope, that theſe, who have read doctor *Ward*'s exercitation, will look upon this cenſure of the Carteſian doctrine by Mr. *Hobbes*, as provoked by that ſevere judgment of *Des Cartes* mentioned by the doctor in theſe words: *Nempe hoc eſt, quod alicubi admiratus eſt magnus Carteſius; nuſquam eum, ſive verum, ſive falſum poſuerit, rectè aliquid ex ſuppoſitionibus ratiocinando inferre:* 'this is the 'thing, that the great *Des Cartes* ſomewhere 'admired, that he, whether his poſitions are 'true or falſe, doth never in argumentation 'make any right inference from his ſuppoſi-'tions.'

Wardi Exer. in Philoſoph. Hobbian. p. 188.

CHAP. III.

Wherein the weight and ſpring of the air are aſſerted, againſt Mr. Hobbes.

HAVING thus diſpatched thoſe general conſiderations, I thought expedient to premiſe, my propoſed method leads me, in the next place, to conſider, that Mr. *Hobbes* does not, that I remember, deny the truth of any of the matters of fact I have delivered. Nor does he, if my memory fail me not, labour to prove, that the explications I have given of my experiments are not agreeable to the doctrine I propoſed: but rather thinks fit to reject our two grand hypotheſes themſelves, the

weight, and the ſpring of the air. And therefore it will ſuffice us in this chapter briefly, but not ſlightly, to prove what he is unwilling to grant.

AND firſt, that the air (in the ſenſe wherein we take the word) is not devoid of weight, we have proved by divers experiments: which having more fully delivered in the book itſelf, it may in this place ſuffice now to name them.

ONE then of theſe experiments, that prove the air's gravity, is, that we found a blown bladder carefully weighed in an exact pair of ſcales manifeſtly heavier, when full of air, than when the air was let out.

NEXT, it has been obſerved in our 36th experiment, that an æolipile, being well heated, and the little hole left at the top of the pipe being ſtopt, when it was thus hot; upon the opening of that hole, when the æolipile was grown cold again, the external air ruſhing in with a whiſtling noiſe at the forementioned orifice, made the æolipile weigh ſo much more than it did juſt before the external air got in, that it amounted, by computation, to near a thouſandth part of the weight of an equal bulk of water. And though ſome difficulty may perhaps be moved touching the accurateneſs of the proportion this way found out, betwixt the gravities of thoſe bodies; yet that the one as well as the other is actually heavy (which is all that we here need contend for) the experiment ſufficiently manifeſts.

THIRDLY, in the Magdeburgick experiment, (mentioned at the beginning of our epiſtle) the ingenious makers of it found, that, having before weighed the great receiver they were to exhauſt, and having done the like after the extraction of the air, they found it to weigh one whole ounce and $\frac{3}{10}$; *quod ſane* (ſays the learned publiſher, though a Peripatetick) *luculentiſſimum eſt argumentum gravitatis aëris*; 'which is indeed a moſt evident argument of 'the weight of the air.'

Exper. Magdeburgicum apud Schotum, p. 446.

FOURTHLY, in our 36th experiment we relate our having weighed the air, and that ſhut up in bodies in our exhauſted receiver, wherein of two bodies of differing natures, (the one a blown bladder, and the other a glaſs bubble) that were æquiponderant each to a more ſolid weight before the air was pumpt out, that which included a good quantity of air did manifeſtly preponderate after the exhauſtion.

AND to theſe four we might add other proofs to the ſame purpoſe; but that theſe contain in them ſuch a variety of caſes, that I think it would be ſuperfluous.

BUT now let us ſee, what Mr. *Hobbes* objects againſt the newly mentioned experiment of the bladder weighed in the exhauſted receiver, (for the others he quarrels not with:) *Quod quidem lanx* (ſaith he) *in qua eſt veſica, magis deprimitur quam altera, certi eſſe poſſunt, oculis teſtibus: quod autem id à gravitate aëris naturali accidit, certi eſſe non poſſunt; præſertim ſi quæ ſit gravitatis cauſa efficiens neſciunt:* 'that the 'ſcale, in which the bladder is, is more depreſt 'than the other, they may be certain, their 'eyes bearing them witneſs; but that this 'comes from the natural gravity of the air he 'cannot be aſſured; eſpecially if they are igno- 'rant what is the efficient cauſe of gravity.' But I know not whom Mr. *Hobbes* will perſuade, that a man cannot be ſure, that lead is *in ſpecie* heavier than cork, unleſs he knows what is the efficient cauſe of gravity. And Mr. *Hobbes* ſpeaks in his 30th chapter (where he expreſly treats of that ſubject) as if that had not been explained by any man, and conſequently not by any writer of ſtaticks; (and perhaps I am therein ſomewhat of his mind:) and yet ſure all theſe writers, treating of the proportion of heavy bodies, did not write they knew not what. And, though he mentions his own hypotheſis, as that *than which nothing is more likely*; yet I think I could frame objections againſt it, that would not eaſily be anſwered, if my preſent taſk required it; or if I found his opinion, in this point, embraced, as yet, by men of note. Wherefore I ſhall now ſay no more of it than he himſelf doth, namely, that according to his doctrine, 'It may well be 'thought to determine (for it is a certain con- 'ſequent) that heavy bodies deſcend with leſs 'and leſs velocity, as they are more and more 'remote from the æquator; and that at the 'poles themſelves they will either not deſcend 'at all, or not deſcend by the axis: which whe- 'ther it be true or falſe, experience muſt de- 'termine.' Which till it have done in his favour (an event I do not expect) I hope he will allow me to diſtruſt his hypotheſis.

Elem. of Phil. Ch. 30. Sect. 4.

BUT to return to our experiment. The account he gives, why the bladder does propend (for ſo he loves to ſpeak) is this; *Quod veſica ſive follibus ſive flatu oris diſtenta ſit, gravior ſit quam eadem veſica non diſtenta, negare nolo, propter majorem quantitatem atomorum follibus vel corpuſculorum fuligineorum ab halitu inflatorum. Ab experimento autem quod ſit à veſica inflata nihil colligunt quod ſit ſatis certum. Oportuit lancibus imponere duo vaſa pondere æqualia, quorum alterum eſſet accuratè clauſum, alterum apertum: ſic enim non inflatus ſed incluſus tantum aër ponderatus eſſet. Quando igitur aërem ſic ponderatum videbis, meditabimur poſtea quid dicendum ſit de phænomeno quod retuleris:* 'that 'the bladder, whether it be blown up with a 'pair of bellows, or with the breath of one's 'mouth, is heavier than when it is not blown 'up, I will not deny, becauſe of the greater 'quantity of atoms from the bellows, or of 'fuliginous corpuſcles, that are blown in from 'the breath. But notwithſtanding they ga- 'ther nothing of ſufficient certainty from this 'experiment of a blown bladder; they ought 'to have put into the ſcales two veſſels of 'equal weight, whereof one ſhould be ſhut 'and the other open: for by this means air 'not blown in, but only incloſed, had been 'weighed. When therefore you ſhall ſee air 'ſo weighed, we will afterwards conſider what 'may be ſaid concerning the phænomenon 'you bring.' But as to the firſt part of this paſſage, it does not deny the gravity of what we call the air; but only endeavours to ſhew what parts they are that make it heavy. And as to the ſecond, he ſeems to miſtake the preſent caſe. For, there is no need, that the air in

Page 15. *Page 16.*

the

the bladder be, before the exhauſtion of the receiver, (in which the foregoing, fifteenth, page declares he ſuppoſes the experiment to be made) heavier than the outward air. Wherefore when he ſubjoins, that from this experiment we collect nothing *quod ſit ſatis certum*, the affirmation is not an inference, but precarious. And as for the annexed way, whereby he would wiſh to have an experiment made fit to infer the gravity of the air, if he had not overlooked what I have delivered in the beginning of the 36th experiment, he would eaſily have perceived, that we did make a trial much of the ſame nature with that he deſires. For we weighed in our receiver the air, in a glaſs hermetically ſealed; wherein it was not (to uſe his expreſſion) *inflated*, but only included. This is what he here objects againſt the gravity of the air in the other place (pag. 8, and 9.) where he ſays ſomething to this controverſy: he inculcates alſo, that we ſhould firſt explicate what is gravity, and then adds, *Quod atmoſphæræ inſunt permiſtæ corpori æthereo multæ tum aquæ tum etiam terræ particulæ, facile perſuadeor; ſed quod in medio æthere, ſurſum, deorſum, quaquaverſum motæ, nec ſemper alteræ alteris innitentes gravitent, inconceptibile eſt:* 'That many 'particles, both of earth and water, mingled 'with the æthereal body, are in the atmoſphere, 'I am eaſily perſuaded: but that in the middle 'of the æther they ſhould move upwards, 'downwards, every way, and that one leaning on the back of another they ſhould not 'gravitate, is a thing utterly unconceivable.' To which he adds two or three reflections, whoſe examen being here unneceſſary, would require more time than perhaps it would (in reference to the preſent controverſy) deſerve: for we are now enquiring, not how the air comes to gravitate, but whether or no it have gravity. And ſince in his Elements of Philoſophy he grants, and gives his reaſon for it, that 'if 'air be blown into a hollow cylinder, or into 'a bladder, it will increaſe the weight of either 'of them a little:' and ſince here he likewiſe confeſſes (as we have juſt now ſeen) that there are mingled with the æther many aqueous and earthly (and conſequently heavy) particles: he confeſſes that, which we labour to evince; namely, that the air is not devoid of weight. And it concerns us no more than himſelf, to ſhew how the corpuſcles, upon whoſe account the air is heavy, make it ſo. And this being what Mr. *Hobbes*, in ſeveral places, thinks fit to object againſt the gravity of the air; the reader will, I ſuppoſe, eaſily take notice, that he has left the experiment of the æolipile, and ſome others, unanſwered. Though theſe alone prove, that the air is a manifeſt weight even when it is not compreſt, but retains its laxity. Having ſaid thus much to evince againſt Mr. *Hobbes* the gravity of the air, let us now examine, whether it have not alſo a ſpring, (in the ſenſe we take that word in*.) This, though Mr. *Hobbes* be pleaſed to call (as he alſo does the weight of the air) *a Dream*; yet he does himſelf grant, in effect, as much as is requiſite to prove the ſpring of the air, in the ſenſe I contend for it. For taking upon him to give account (how good an one we ſhall ſee anon) of that known experiment, wherein the air is compreſt in a glaſs-bottle by the forcible injection of water; which water, when the glaſs is unſtopt, the air does again throw out in recovering its former dimenſions; of this experiment (I ſay) he gives this account, (pag. 24.) *Aër, quo ab initio ſphæra plenus erat à corpuſculis illis terreis motus motu circulari ſimplice, vi injectionis coactus, qui quidem purus eſt, exit (aquam injectam penetrans) in aërem extrinſecum, locum relinquens aquæ; ſequitur ergo corpuſculis illis terreis minus relinqui loci, in quo motum ſuum naturalem exercere poſſint: itaque in ſe mutuo impingentes aquam urgent ad egreſſum; egredientem aër externus (quia univerſum ſupponitur eſſe plenum) penetrat, locumque egredientis aëris ſucceſſivè occupat, donec corpuſcula, quantitate aëris eadem reſtituta, libertatem motui ſuo naturalem recipiant.* 'The air, with which in the beginning the ſpherical glaſs was full, being 'moved by thoſe earthy corpuſcles in a ſimple 'circular motion, and being compreſt by the 'force of the injection, that of it which is 'pure (penetrating the injected water) gets 'out into the open air, and gives place to the 'water. It follows therefore, that thoſe earthy 'corpuſcles have leſs place left, in which 'they can exerciſe their natural motion: therefore beating one upon another, they force the 'water to go out; it thus going out, the external air (becauſe the univerſe is ſuppoſed to be 'full) penetrates it, and ſucceſſively takes up 'the place of the air, that goes out, until the 'corpuſcles, the ſame quantity of air being reſtored, regain a liberty natural to their motion.'

Page 9.

Chap. 30. Sect. 10.

But how little this comes ſhort of granting as much ſpring to the air as the Carteſians do, and as I need require, may eaſily be judged by divers paſſages in our book; and particularly by our propoſing, as not improbable, the Carteſian way of explicating the ſpring of the air; according to which, the corpuſcles, that ſwim in the æther, being each hindered by the neighbouring ones from the freedom of its motion, they beat off one another, (which Mr. *Hobbes* would have them do:) whence it comes to paſs that, in any aſſigned portion of air here below, the corpuſcles, that compoſe that portion, beaten off by one another, do make the whole portion tend to obtain (though not exactly to fill up) more room, and conſequently to emulate a ſpring, like that which we ſcruple not to aſcribe to a compreſt fleece of wool, becauſe of a like endeavour to expand itſelf.

We may inforce this by another paſſage of Mr. *Hobbes*'s, that ſpeaks expreſly enough to our preſent purpoſe, where he gives this reaſon of one of the phænomena of our engine: *Quoniam per ſuctoris retractionem aër purus impulſus erat, partes autem terreæ impulſæ non erant; major erat ratio particularum terrearum, quæ extra cylindrum ſuctori contiguæ erant, ad aërem purum, in quo motum ſuum exercebant, poſt revulſionem quam ante: quare particulæ illæ motæ minus*

* *Utraque enim illa phantaſia, tum gravitatis atmoſphæræ, tum vis elaſticæ ſive antitupiæ aëris, ſomnium erat.* Dial. pag. 21.

minus habentes loci ad motum ſuum naturalem exercendum, aliæ aliis impingebant, & propellebant: neceſſe ergo erat, ut particulæ, quæ ſuctoris ſuperficiei contiguæ erant, ſuctorem propellerent *: 'becauſe by the drawing back of the 'ſucker the pure air was thruſt in, but the 'earthy parts were not thruſt in; there was a 'greater proportion of earthy particles, which, 'without the cylinder, were near the ſucker, 'unto the pure air, in which they exerciſed 'their motion as well after this revulſion as 'before. Wherefore theſe particles ſo moved 'having leſs place to exerciſe their natural mo-'tion in, ſome of them fell foul and beat upon 'the reſt. So that of neceſſity the particles, 'that were near the ſurface of the ſucker, muſt 'drive it upwards.' To which we may add, that Mr. *Hobbes* himſelf ſeems rather to reject other men's ways of propoſing the ſpring of the air, than reſolutely to deny the thing itſelf. For, *Vidiſti* (ſays he) *jam elaſtrum illud aëris, quod ſupponunt, aut impoſſibile eſſe, aut recurrendum eſſe ad hypotheſin Hobbianam:* 'you ſee 'now, that the ſpring of the air, which they 'ſuppoſe, is either an impoſſible thing; or 'they muſt (for its defence) have recourſe to 'the hypotheſis of Mr. *Hobbes.*'

BUT beſides Mr. *Hobbes's* conceſſions in the paſſages newly recited, and ſome others, we can prove the ſpring of the air by many of the phænomena of our engine, which we have deduced from it, and of which he does not offer any other way of explication. Wherefore we ſhall now content ourſelves to prove the ſpring of the air by two experiments; the one not mentioned in our epiſtle, and the other much oppoſed by Mr. *Hobbes.*

AND firſt, if you make the Torricellian experiment in a tube of between two foot and a half and three foot in length; and if, when the mercury reſts at its wonted ſtation, you dextrouſly ſtop the orifice of the tube with your finger, (that orifice being lifted up as near the ſurface of the reſtagnant mercury as it can be, without giving admiſſion to the external air) and if then you quite lift up the tube thus ſtopt into the free air; you ſhall feel, upon your finger, little or no gravitation or preſſure from the weight of the mercurial cylinder, diſtinct from the weight of the tube: becauſe (as we have more fully explicated this phænomenon elſewhere) the gravity of the quickſilver is balanced by that of the outward air, that thruſts the finger againſt it. But if you invert the tube, and having let in the air at the orifice, ſtop it again with your finger, and again let the mercurial cylinder lean upon that finger; you ſhall then find your finger ſtrongly preſt, and endeavoured to be thruſt away: which new preſſure, ſince it cannot come from the mercury, that being the very ſame, that was in the tube before, nor from the weight of the admitted air, which perhaps may not amount to ſo much as a grain, to what can we rationally aſcribe it, but to the ſpring of the included air, whoſe force will be as well manifeſt to the eye as the finger, if the tube be unſtopt under the ſurface of the reſtagnant mercury; for then that in the glaſs will not reſt, as before, at the uſual ſtation, but be depreſt beneath it a good way, perhaps ſome inches? And if you make the Torricellian experiment in a ſhort tube ſealed at neither end, but ſtopt above and below with your fingers, you ſhall find, upon the unſtopping of the upper orifice a new and forcible preſſure upon the finger, that keeps the lower orifice ſtopt, made by the gravitation of the external air, which was before kept off from leaning upon the mercurial cylinder by the upper finger; the pulp of which finger, by that gravitating air, was before thruſt into the deſerted cavity of the tube, (as we have elſewhere diſcourſed, in a fuller meaſure, of theſe experiments.) Which will evince, againſt Mr. *Hobbes*, both the ſpring of the air and gravity of the atmoſphere; ſince he is, as little as I, for aſcribing theſe phænomena to the efficacy or abſence of my other antagoniſt's imaginary Funiculus.

In our Defence againſt Linus.

THE other experiment I ſhall mention is the fourth in our epiſtle; namely, that of the ſwelling and ſhrinking of a bladder hung in our receiver, according as the ambient air, and conſequently its preſſure, is withdrawn or ſuffered to return. But though this experiment be ſo congruous to our hypotheſis, that it is generally acquieſced in by thoſe ingenious men, that have hitherto ſeen it; yet Mr. *Hobbes* is pleaſed to reject our explication, and ſubſtitute another in theſe words, which is all he has concerning this matter: *Quia cuticula omnis ex* Page 19. *filiculis conſtat, quæ propter figuras contactum per omnia puncta accuratum habere non poſſunt, pervia ergo eſt veſica, cum ſit cuticula, nec aëri tantum, ſed etiam aquæ, qualis eſt ſudor. Eadem ergo aëris per vim incuſſi eſt compreſſio intra veſicam, quæ extra, cujus conatus, propter viam motuum undiquaque decuſſatum, tendit undiquaque ad ſuperficiem veſicæ concavam. Quare neceſſarium eſt, ut undiquaque intumeſcat, & creſcente conatûs vehementiâ tandem laceretur.* 'Becauſe 'every ſkin is made up of ſmall threads or fila-'ments, which by reaſon of their figures can-'not accurately touch in all points; the blad-'der therefore, being a ſkin, muſt be pervious 'not only to air, but to water alſo, as to 'ſweat: therefore of the air beat in by force, 'there is the ſame compreſſion within the 'bladder, that there is without. The endea-'vour of which, the way of its motions being 'every way croſs, tends every way to the con-'cave ſuperficies of the bladder. Wherefore 'it is of neceſſity, that it muſt ſwell every way, 'and the vehemency of the endeavour in-'creaſing, be torn at laſt.' But, if this be a ſufficient anſwer to ſuch an experiment, I confeſs I fear it will be harder than we are yet aware of, to prove any thing by experiments.

FOR, firſt, how unlike is it to be true what he affirms, and what his reply ſuppoſes, namely, that

* The motions therefore of thoſe ſmall bodies (ſpeaking of the earthy particles in the air) will be leſs and leſs free, by how much the quantity of the injected water is greater and greater: ſo that by their motion falling upon one another, the ſame bodies will mutually compreſs each other, and have a perpetual endeavour of regaining their liberty, and of depreſſing the water that hinders them. *Elem. chap.* 30. *ſect.* 9.

that ſuch bladders as we uſed are readily pervious to the air; when eaſy experience ſhews us, that by leiſurely compreſſing ſuch blown bladders betwixt our hands, we ſhall rather break them (as we have tried) than ſqueeze out the air at the pores? So that the reſt of his anſwer being built upon what is ſo repugnant to common experience, will not need a particular confutation: but however, *ex abundanti* we will add, that in our 36th experiment we relate, that by the exhauſtion of the air we likewiſe broke a glaſs hermetically ſealed; and to ſay that glaſs alſo is pervious to air, were to affirm what the greateſt part of his book ſuppoſes to be falſe. Beſides, whereas there is not any ſenſible and unqueſtionable phænomenon to prove, that the receiver is full of any ſuch *aër per vim incuſſus* as he would have, we ſee plainly, that when the air does manifeſtly get into the receiver, the bladder is not thereby made to ſwell, but ſtrangely to ſhrink. Moreover, ſince (according to Mr. *Hobbes*) the bladder is pervious to the air, and the air within the receiver is univerſally compreſt, as well that which is within the bladder as that which is without it; how comes it to paſs, that the air, that bears againſt the convex ſurface of the bladder, does not reſiſt that which is contiguous to the concave ſuperficies of the ſame; and at leaſt, how comes the bladder to be broken by the air; which, according to Mr. *Hobbes*, can get in and out at pleaſure? And laſtly, to ſhew, that to the ſwelling of the bladder there needs nothing but the ſpring of the included air, and not ſuch vehement agitation of the ambient air, as Mr. *Hobbes* ſuppoſes to be made in our engine; it appears by the elſewhere-mentioned experiment of Monſieur *Paſchal*, that in the free and ordinary air a foot-ball half blown up will ſwell more and more, the nearer it is carried to the top of an high mountain; where the incumbent cylinder of the atmoſphere is ſhorter, and its weight lighter; and will, for the contrary reaſon, grow more and more flagged, the nearer it approaches again to the foot of the mountain.

THOUGH I doubt not, but the arguments employed in this chapter will be ſufficient to convince impartial readers; yet I ſhall add, by way of inforcement, that whereas Mr. *Hobbes* aſcribes the weight of the air in bladders to the earthy corpuſcles intruded by him, that blows them up; and attributes the ſpring of the air in the wind-gun, and in the phænomena of our engine, to the violent motion the air is put into by the vehement impulſes of the rammer or ſucker; our doctrine may be evinced by experiment, wherein the air in its natural and wonted ſtate operates, without being forcibly compreſt or put into motion by us. This may appear by the two ſorts of experiments to be made upon high mountains, which we have mentioned and urged in the *ſecond part* of our *defence againſt the learned* Linus. Wherefore referring the reader thither, we ſhall now only, in very few words, mention the ſubſtance of them.

THE firſt experiment is, That it has been found upon trial, both formerly in *France* and ſince in *England*, that the quickſilver in the Torricellian experiment falls notably lower at the top of a mountain than at the foot, (by Monſieur *Paſchal*'s obſervation upon a hill, far higher than thoſe the experiment was tried on here, the difference was ſo great, as to amount, as the moſt ingenious *Pecquet*, a happy promoter of experimental learning, informs us, to above three inches;) which we ſay is cauſed by this, that the atmoſpherical cylinder is much lighter, as well as ſhorter at the top of the mountain than at the bottom. And Mr. *Hobbes* diſallows not the experiment, but yet gives only this account of it: *Sed & particulæ illæ, quæ interſperſæ aëri ita moventur, ut ſuppoſuimus, magis confertæ ſunt ad radicem montis quàm in ſummo, nam hoc quoque ſuppoſuimus.* But what then? How does the plenty of theſe interſperſed particles hinder the mercurial cylinder from deſcending at the bottom of the hill as much as at the top, unleſs by their gravity or preſſure? And it is very unlikely, that the earthy atoms, contiguous to the reſtagnant mercury at the bottom of the hill, ſhould be able, by their weight, to keep ſuſpended a cylinder of mercury of above three inches, unleſs the contiguous air were gravitated upon by the weight of other incumbent parts of the atmoſphere. Page 12.

THE other of the two mentioned experiments is briefly this, That a thermoſcope being carried from the bottom to the top of a hill, the included air, inſtead of ſhrinking in that colder region, manifeſtly dilated it ſelf, and notably depreſſed the water. An effect which I ſee not to what it can well be attributed but to the ſpring of the included air, which having not near ſo great a preſſure againſt it from the atmoſphere incumbent on the reſtagnant and ſuſpended water, was able to make it ſelf more room than before it could; and ſince that preſſure of the atmoſphere depends, for aught appears, upon its gravity, the ſame experiment may argue both the ſpring of the air and its weight.

AND this may ſuffice for our third chapter, wherein having evinced againſt Mr. *Hobbes* our grand hypotheſis of the weight and ſpring of the air, I hope we have diſpatched the chief part of our work; ſince as for the particular explications we deduce from theſe hypotheſes, there are but very few, if any, that he endeavours to prove incongruous to them. Yet after we ſhall have (in the following chapter) conſidered upon what grounds he prefers his doctrine before ours, we ſhall (God permitting) in two or three other chapters gather up the things, that he objects againſt ſome particular opinions and explications by us delivered, and examine them.

CHAP. IV.

Wherein Mr. Hobbes's *principal explications of the phænomena of the author's engine are examined.*

OF the hypotheſes, that Mr. *Hobbes* aſſumes, to explicate the phænomena of our engine, himſelf gives us a ſummary in this paſ-

ſage, (*pag.* 10.) *Intellexti ergo hypotheſes meas? 1. Quod aëri interſperſæ ſunt particulæ multæ terreæ præditæ motu circulari ſimplice, naturæ congenito. 2. Quod major eſt quantitas earum particularum in aëre propè ad terram, quàm in aëre à terra remotiore:* 'Have you underſtood 'my hypotheſes? 1. That there are with the air 'interſperſed many earthy particles, endued with 'a ſimple circular motion, congenite to its nature. '2. That there is a greater quantity of theſe 'particles in the air that is near the earth, than 'in that which is more remote from it.'

Now here I might at the beginning take notice, that there are other things, which he takes for granted. As, firſt, *Non dari Vacuum*, which, as we have already ſeen he has not well evinced, nor I think eaſily will, upon the grounds he proceeds on. Next, that our common air is chiefly compoſed of an æthereal ſubſtance, which methinks he ſhould have proved; ſince for the moſt part the Vacuiſts (and ſuch he will needs have his adverſaries to be) admit not that pure air of his. Thirdly, that the air, at leaſt the pure air, is eaſily diviſible into parts always fluid and always air. Indeed he ſays of this aſ-
Pag. 4. ſumption, *Nec ſuppono tantùm, ſed credo*; but neither to ſuppoſe nor to believe, is to prove.
Ibid. And what he adds, *Neque eſt qui hactenus ullam adduxit rationem, quare ita eſſe non poteſt:* 'Nor is there any one, that hitherto has brought 'any reaſon why it may not be ſo:' if it were true, would conclude little, ſince many things have not been, and perhaps cannot be, proved to be true; of whoſe not being poſſible no proof has been given. We might, I ſay, mention and examine theſe other aſſumptions of our author, but for brevity ſake we will conſider thoſe two lately recited from him.

AND as for the ſecond of them, bating the peculiar motion he is pleaſed to aſcribe to the earthy particles, I ſhall not contend with him about that hypotheſis; and therefore ſhall now only conſider the other. The *Motus circularis ſimplex* it ſelf, which he imagines, in the ſun and the terreſtrial globe, I ſhall not need to examine, ſince Dr. *Ward*, (a perſon whom, without diſparagement to a famous man, I may affirm to be at leaſt as eſteemed for aſtronomy as Mr. *Hobbes*) has expreſly endeavoured to confute it, and that not without ſome deriſion, (which yet I willingly forbear to imitate) by arguments, that I cannot learn Mr. *Hobbes* has yet anſwered. And I am informed, that the learned Dr. *Wallis*, and others, intend ſome animadverſions on this motion. But reſtraining our preſent conſideration to what this Dialogue ſuggeſts to me, this aſſumption to me ſeems very precarious, ſince I know not any unqueſtionable example or experiment, whereby it can be made out, that any ſmall parcel of matter has ſuch a *motus circularis ſimplex*, as he aſcribes to each of theſe innumerable earthy, and (as himſelf adds in the ſame page) aqueous particles. The only argument he brings in that page to prove, that each atom would have this motion, if all the reſt of the earth were annihilated, does not to me ſeem clear. For, not to mention, that it is ſtill by many learned men doubted, whether the terreſtrial globe it ſelf have it; nor to examine, whether or no he aſſigns a good natural cauſe of it; it is not always true, that each minute part of a homogeneous body (which yet it will be hard to prove the terreſtrial globe to be) has in every reſpect the ſame qualities with the whole; as the roundneſs, which a ſmall drop of water or quickſilver is commonly obſerved to have when it leans upon a dry or greaſy plain, is not to be met with in great portions of either of thoſe liquors, though placed upon the ſame plain. And Mr. *Hobbes*, as well as we, makes the terrene atoms in the air to have gravity, which yet is a quality, that does not properly belong to the whole globe of the earth; nor is it manifeſt, why, becauſe the terreſtrial globe moves in a vaſt circle about the ſun, each particular atom of it muſt deſcribe a ſmall circle in the air about I know not what centre. And ſince he teaches in his ſecond hypotheſis, and a few lines before it, that the air, near the earth, abounds with ſuch terrene corpuſcles, it is not likely they ſhould be permitted to exerciſe ſuch a regular motion as he attributes to them; but hitting againſt one another, they muſt in probability be put into almoſt as various and confuſed a motion, as *Des Cartes* aſcribes to his terreſtrial particles ſwimming in the atmoſphere. That which ſome will, I doubt not, peculiarly wonder at in Mr. *Hobbes*'s hypotheſis, is, that he makes this regular motion of each atom *naturæ ſuæ congenitus:* for philoſophers, that are known to wiſh very well to religion, and to have done it good ſervice, have been very ſhy of having recourſe, as he has, to creation, for the explaining of particular phænomena. And the Carteſians will think it at leaſt as allowable for them to ſuppoſe the motion he will not grant in their *materia ſubtilis*, as for Mr. *Hobbes* to aſſume it in his *particulæ terreæ*; eſpecially ſince he ſeems to make each ſuch atom put into and kept in a regular motion; whereas they aſſume but the having of one general impulſe given to the whole maſs of matter. Thoſe likewiſe, that fancy a ſpring properly ſo called in particular aerial corpuſcles, will hence perhaps take occaſion to think they may ſuppoſe an ingenite motion fit for their turn, as well as he an ingenite *motus circularis ſimplex*. How well likewiſe this hypotheſis will agree with his fundamental doctrine, that *Nihil movetur niſi à corpore contiguo & moto:* 'Nothing is moved 'but by a contiguous body that is in motion:' I leave to him to conſider. As alſo whether or no *Gaſſendus*, and thoſe other Atomiſts that admit creation, may not hence countenance their grand ſuppoſition of the congenite motion of atoms, which granted, would deſtroy the beſt part of Mr. *Hobbes*'s philoſophy. But whatever becomes of this *motus circularis ſimplex*, I need not be much ſollicitous, having formerly ſhewn, that the admiſſion of it would not diſprove what I have delivered concerning the ſpring of the air: and therefore leaving Mr. *Hobbes* to diſpute it out, if he think fit, with his other adverſaries, I will proceed to the main explications, wherein Mr. *Hobbes* endeavours to prefer his doctrine about the phænomena of our engine before ours. And theſe I find to be the four that enſue.

THE

THE firſt and principal of theſe is that, wherein he ſtrives to prove, that by the exhauſtion of our cylinder no vacuum is produced, and to give of the experiment itſelf a very differing account from ours. This he does in the following paſſage; which, by reaſon of its importance in our preſent controverſy, we ſhall ſet down *verbatim*: *Dum ſuctor* (ſays he) *retrahitur, quanto relictus locus major fit, tanto minus loci relinquitur aëri externo, qui retruſus à ſuctore moto verſus externa, proximum ſibi aërem ſimiliter movet, & hic alium, & ſic continuè, ita ut neceſſe ſit aërem tandem compelli in locum deſertum à ſuctore, & intrare inter ſuperficiem ſuctoris convexam & cylindri concavam: ſuppoſito enim aëris partes eſſe infinitè ſubtiles, impoſſibile eſt, ut viâ illâ, qua retrahitur ſuctor, illæ non ſe inſinuent. Primò enim, contactus ſuperficierum iſtarum per omnia puncta perfectus eſſe non poteſt, quia ipſæ ſuperficies fieri infinitè læves non poſſunt. Deinde vis illa, quæ ad ſuctorem revellendum adhibetur, cavitatem cylindri aliquantulum diſtendit. Poſtremo, ſi in confinio duarum dictarum ſuperficierum ingrediatur una tantum atomus dura, aër purus eâ viâ ingreditur conatu quantumvis debili. Poteram etiam computaſſe aërem illum, qui propter eandem cauſam inſinuaſſet ſe per cylindri valvulam. Sublatam ergo vides conſequentiam à retractione ſuctoris ad locum vacuum. Sequuturum hoc quoque eſt, aërem illum, qui eſt in locum à ſuctore deſertum impulſus, quia magnâ vi impulſus eſt, motu valde celeri & per circuitum inter ſummum & imum in cylindro moveri; cum nondum ſit, quod motum ejus poſſit debilitare: ſcis autem nihil eſſe, quod ſibi motum aut impertiri poſſit aut diminuere.* ‘ While the ſucker is drawn ‘ back, by how much a greater place is left ‘ (within,) by ſo much a leſſer place is left to ‘ the external air; which being thruſt back- ‘ wards by the motion of the ſucker towards ‘ the outmoſt parts, doth move in like man- ‘ ner the air that is next itſelf, and that air the ‘ next, and ſo forwards: ſo that it is of ne- ‘ ceſſity at laſt, that the air muſt be compelled ‘ into the ſpace deſerted by the ſucker, and to ‘ enter between the convex and ſurface of the ‘ ſucker, and the concave of the cylinder. For ‘ it being ſuppoſed, that the parts of the air are ‘ infinitely ſubtile, it is impoſſible but they ‘ ſhould inſinuate themſelves that way, by which ‘ the ſucker is drawn down. For firſt, the ‘ contact of thoſe ſurfaces cannot be perfect ‘ in all points, becauſe the ſurfaces themſelves ‘ cannot be made infinitely ſmooth. Then, ‘ that force, which is applied to draw back the ‘ ſucker, doth diſtend in ſome meaſure the ‘ cavity of the cylinder. Laſtly, if in the ‘ confines of (that is, betwixt) the two ſur- ‘ faces, any one ſingle hard atom ſhould enter, ‘ pure air will enter at the ſame way, although ‘ with a weak endeavour. I might alſo have ‘ accounted that air, which for the ſame ‘ cauſe inſinuates it ſelf through the valve ‘ of the cylinder. You ſee therefore the ‘ conſequence from the retraction of the ‘ ſucker, to the being of an empty place, is ‘ taken away. It will follow alſo, that the ‘ air, which is driven up into the place deſerted ‘ by the ſucker, becauſe it is driven up-thither ‘ by a great force, is moved with a very ſwift ‘ and circular motion betwixt the top and the ‘ bottom in the cylinder, becauſe there is no- ‘ thing there, that can weaken its motion: and ‘ you know, that there is nothing, that can give ‘ motion to its own ſelf, or diminiſh it.’ But this ratiocination containeth divers things liable to exceptions: and in order to the examining of it I muſt premiſe, that I know not, why Mr. *Hobbes* ſhould here confine his diſcourſe to the pump, without taking notice of the glaſs, for whoſe evacuation it was deſigned. Wherefore, for eaſier conſideration ſake we will conſider, how this diſcourſe will account for the exhauſtion of the receiver, as well as for the cylinder; for we uſually empty them both in the ſame trials. And he being obliged to explicate the exhauſtion of the one as well as the other, it will be convenient to take into conſideration the receiver alſo; becauſe that being of glaſs and tranſparent, we can better ſee what happens in it than in the opacous cylinder. This premiſed, we may now proceed to the exceptions themſelves. And, firſt, I do not clearly ſee by this explication how he avoids a vacuum: for, according to his firſt words, the external air is diſplaced by the motion of the ſucker outward, and this diſplaced air muſt move that which is next to it, and that the next, and ſo onward, (whether *in infinitum* or no, he declares not;) ſo that at length (*tandem*) the air muſt be compelled into the place deſerted by the ſucker: ſo that till this returning air get in betwixt the ſucker and the cylinder, how appears it from this diſcourſe, that the deſerted ſpace was not empty for ſome little while? For, certainly, all theſe motions of the air forward and backward could not be performed in an inſtant; as may appear by the motion of ſounds and echoes, whoſe velocity is reducible to meaſure. Secondly, though he takes his adverſaries to be Vacuiſts, yet (to give an account of theſe phænomena) he ſuppoſes the plenitude of the world; as may appear both by expreſs paſſages in his dialogue, and by his here rendering no other probable cauſe of the air's getting into the room relinquiſhed by the ſucker. But, becauſe I have not here taken upon me the perſon of a Vacuiſt, I ſhall offer ſome other conſiderations. I wiſh then, thirdly, that Mr. *Hobbes* had declared from whence the regreſs of the air's impulſion ſhould begin; for that may well be required from one, that, making the world full, and for aught appears (the celeſtial globes excepted) fluid, allows us to believe it infinite, if the magiſtrate ſhall pleaſe to enjoin us that belief. Fourthly, I demand what neceſſity there is, there ſhould be ſuch a forcible return of the impulſe, as is requiſite to thruſt in the air at ſo narrow a paſſage, as that between the ſucker and cylinder. For, why may not that impulſe, when diffuſed in the vaſt ambient medium, be ſo communicated and blended among the differing motions of the other parts of it, as not to return again from whence it begun? As we ſee that a voice, though ſtrong, will not move the air beyond a certain diſtance, ſmartly enough to be reflected in an echo to the ſpeaker: and a ſtone caſt into a lake will have the waves it

Page 5.

makes

makes diverted from returning to the place they began at. Fifthly, I do not likewiſe ſee, that it is proved, or probable, what Mr. *Hobbes* affirms of ſo thick a cylinder as ours, that it ſhould be diſtended by the depreſſing of the ſucker. But this I inſiſt not on; for the main thing, that is peculiar in Mr. *Hobbes*'s explication, is, that as much air as is driven away by the ſucker, gets preſently in again betwixt it and the cylinder: wherefore let us examine that a little. I ſay then, that by the air, which is ſo ſuppoſed to get in, he either means, in the uſual ſenſe and in ours, the common air, ſuch as we live and breathe in, or he does not.

IF he do ſpeak of ſuch air, I can plainly prove by ſeveral experiments, that our engine is in great part devoid of it.

FOR, firſt, if there be a contrivance made, whereby the whole pump may be covered with water, one may, as we have tried, plainly ſee the air, that is drawn out of the receiver, at each reciprocation of the ſucker, paſs in great bubbles out of the valve through the water.

NEXT, it appears by the *Magdeburg* experiment formerly mentioned, that by reaſon of the receſs of the air, the globe of glaſs, whence it went out, was diminiſhed in weight above an ounce. Thirdly, the ſame truth may be proved by the experiments formerly mentioned of the ſwelling of a bladder, and the breaking of an hermetically-ſealed glaſs upon the receſs of the ambient air; theſe experiments having been already vindicated from Mr. *Hobbes*'s very improbable explications of them. Fourthly, the ſame may be proved by the breaking of weak or ill-figured receivers inwards; of which in our hypotheſis the reaſon is clear, but not in Mr. *Hobbes*'s. But, fifthly, (not to multiply inſtances, though that were eaſy for me) what I contend for may be ſufficiently proved by this one phænomenon, that though, if the receiver being full of common air the key be turned under water, the water will not at all be ſpurted up at the open orifice: yet the like being done after the exhauſtion of the receiver, we have had divers gallons of water violently impelled into the cavity of the glaſs; which could not happen if it were full of air, both in regard there can be no probable cauſe aſſigned, why the water ſhould be thus ſpurted up; and becauſe the receiver being already full of air, either two bodies muſt be contained in one place, and ſo we muſt allow penetration of dimenſions; or elſe common air, to which glaſs is impervious, muſt paſs through the water, which we conclude it does not, becauſe no ſuch bubbles are made in the external water as would appear if common air paſſed through it. Nay, ſo little of this common air was ſometimes left in the globe uſed at *Magdeburg*, that when the water was ſuffered to ruſh in, it reduced the air into leſs by the beholder's eſtimate, than the thouſandth part of the capacity of the globe: and even if our receiver be unſtopped, not under water, but in the open air, the ambient air will violently preſs in, with a noiſe great and laſting enough to argue, that the glaſs was far from being full of ſuch air before.

AND thus we may argue againſt Mr. *Hobbes*, if he would have the engine, when we call it exhauſted, filled with common air, as his words in the recited paſſage (where he talks of the external air, and that impelled into the cylinder, without differencing them) ſeem to intimate. But becauſe by ſome other paſſages of this Dialogue he may be favourably thought to mean, that the pure air (as he ſpeaks) is that, which gets in by the ſides of the ſucker into the pump, and ſo into the receiver; let us conſider his explication in this ſenſe alſo. And not to urge, that it had not been amiſs, if, to avoid ambiguity, he had more clearly expreſſed himſelf, and named that other here, as well as he elſewhere calls it ſo; not to urge this, I ſay, I deſire it may be taken notice of, that if Mr. *Hobbes* take the air in this ſecond notion, he oppoſes not what I have delivered; the air I pretend to be pumped out of the receiver being the common air, which conſiſts in great part of groſſer corpuſcles than the æthereal ſubſtance: and therefore I might ſafely paſs on to another ſubject. But I conſider further, that even this explication of Mr. *Hobbes*'s will be liable to the two firſt inconveniences lately objected againſt the other in favour of the Vacuiſts; and to divers of thoſe things beſides, that are objected in the following parts of that diſcourſe. Next I obſerve again, that though the pump be all the while kept under water, yet the exhauſtion of the cylinder and receiver will be made as well as in the open air. I demand then of Mr. *Hobbes*, how the pure air gets in by the ſides of the ſucker that is immerſed in water? I preſume, that for want of a more plauſible anſwer he will here ſay, (as he elſewhere does in an almoſt parallel caſe,) that the air paſſes through the body of the water to fill up that deſerted ſpace, that muſt otherwiſe be void: but then I appeal to any rational man, whether I am obliged to believe ſo unlikely a thing upon Mr. *Hobbes*'s bare affirmation. If I be, I muſt almoſt deſpair to prove things by experiments; and if he will allow me to expect from him as much as he ſeems to do from me, I ſhall ſcarce deſpair to maintain almoſt any hypotheſis I pleaſe: for, beſides that he does not ſo much as pretend by any phænomenon to countenance this bold aſſertion, there are phænomena, that make againſt it. For I know not how many experiments ſhew us, that when air paſſes through water, it makes bubbles there, which in our caſe do not appear. And beſides, I ſee not, why the outward air ſhould not rather impel the water (as we ſee it frequently does in ſuch caſes) than be ſuppoſed to dive ſo ſtrangely and unperceivedly through it. When alſo the diligently-exhauſted receiver is unſtopped under water, he that obſerves, how the water ruſhes in with a ſtream as big as the paſſage will give leave, will hardly imagine, that at the ſelf-ſame time, as much air, as there gets in water, can paſs through the ſame hole without being perceived. But it may by Pleniſts be ſaid in Mr. *Hobbes*'s behalf, and it ſeems the moſt that can be ſaid, that either his explication, or a vacuum muſt be admitted. To which I reply, firſt,

that

that he has not evinced there can be no vacuum; having endeavoured to prove it but by a ſingle experiment, which at beſt does not more ſtrongly plead againſt a vacuum than this does for it. Next, that we have lately made it probable, that by his explication he does not avoid the neceſſity of a vacuum. And thirdly, that a Peniſt, without having recourſe to Mr. *Hobbes*'s precarious *diving* of the air, may more probably decline the neceſſity of yielding a vacuum by ſaying, according to the principles of the Carteſians, (the ſubtileſt and varieſt champions for a plenum I have yet met with) that the æther is, by the impulſe of the depreſſed ſucker, and the reſiſtance of the ambient bodies, ſqueezed in at the pores of the glaſs or cylinder into the cavity of the veſſel, as faſt as room is there made for it. And I confeſs, I ſomewhat wonder at Mr. *Hobbes*'s being averſe to this way of ſolving the objected difficulty, ſince (a little above the middle of that paſſage of his we have ſo long been examining) he ſuppoſes the parts of the air to be infinitely ſubtile; which if they are, I know not what pores can be too narrow for them to inſinuate themſelves into. But, to preſs this no further, I muſt here take notice, that whether the cavity of the receiver be reſolved to be (totally or in part) empty or full of Mr. *Hobbes*'s ætherial body, or the Carteſians celeſtial matter; the violent ruſhing in of the water, when the veſſel is unſtopped under that liquor, and divers other phænomena, which will not be aſcribed to the ſubtile matter within, (to which they attribute not any attraction) ſufficiently argue, that there is in the external air a far greater power of preſſing inwards, than there is within of reſiſting; and conſequently ſuch a weight or ſpring in that air as my epiſtle challenges to it. I had almoſt forgot to anſwer the laſt lines of Mr. *Hobbes*'s ſo often mentioned paſſage, where he would have the air, that he ſuppoſes to be impelled into the ſucker, to move very ſwiftly betwixt the top and bottom of it. And ſo elſewhere he would have the ſame air, when it gets into the cavity of the receiver. But having tired my ſelf, as I fear I have you, by dwelling ſo long upon one paſſage; I will ſkip ſomewhat, that I here approve not in the ratiocination, and only ſay, that when a light bladder is ſuſpended in the cavity of the receiver, it betrays no ſuch motion as is here imagined; nay, the flame of a taper, as our epiſtle mentions, was not blown out, nor (for aught appeared) ſtirred by this ſuppoſed wind: to which I ſhall add, that ſmoke produced in the receiver, whilſt it remained exhauſted, was not by this vehement motion of the air blown about the receiver, as is particularly ſet down in our Appendix, promiſed by the tranſlator of the newly-mentioned treatiſe. But if you let in the common external air at the ſtop-cock, that indeed will ruſh in with noiſe and violence, and whirl about the bladder, that hung quietly enough before.

Having thus examined Mr. *Hobbes*'s firſt ſolemn explication, I now proceed to the next; wherein he undertakes to give an account by his hypotheſis of the reaſon, why in our engine, if the manubrium of the depreſt ſucker happens to ſlip out of the pumper's hand, the ſucker is carried up again towards the top of the cylinder. But ſince this explication is ſuch, that though he mentions it as his firſt, preſently after the recital of his two hypotheſes, he himſelf is pleaſed to confeſs in the laſt page of his book, that it is erroneous; I ſhall forbear to vex it, thinking ſuch acknowledgments more fit to be imitated, whenever there is the like occaſion, than to be diſcouraged. But as for the explication, which at the end of his Dialogues he ſubſtitutes for his retracted one, I confeſs to me it is ſo obſcure, that I know not well what to make of it. But, as far as upon conſideration I can underſtand it, it is coincident with that, which in our method will be called his fourth explication; with which, that it may the better agree, ſeems one of the chief reaſons of his altering it from what we had propoſed at firſt. Wherefore we ſhould preſently fall upon examining them both together; but that between them I meet with an explication (which in our reckoning is the third) of the Torricellian experiment.

And here he ſpends many words to prove the opinion he had, whether propoſed or adopted, in his Elements of Philoſophy; namely, that the place deſerted by the ſuſpended mercury is not empty, but full of air. But becauſe this expoſition aſſumes what he has not yet demonſtrated, *viz. non dari vacuum*, and becauſe the Torricellian experiment, as it is wont to be made, is none of the phænomena of our engine; I ſhall refer you to what thoſe learned men Doctor *Ward* and *Moranus* have profeſſedly, and the firſt of them largely enough, written againſt Mr. *Hobbes*'s Explication, (yet without making all that either of them teaches mine:) becauſe, for my part, it will ſuffice me to argue, as I did before, that if he takes the air in the common ſenſe of the word, (and that wherein his readers generally underſtand him) his conceit is manifeſtly repugnant to ſeveral ſuch phænomena as theſe. That if the experiment be very well made, we may, by inclining the tube, impel the mercury from its wonted ſtation to the top of the tube; which will not happen, in caſe the air were before inclination let into that deſerted ſpace. That if, when the mercury is ſettled at its wonted ſtation, the tube be lifted up out of the re-ſtagnant quickſilver, the outward air will drive up the heavy mercurial cylinder oftentimes with force enough to beat out the ſealed end. To which we ſhall add only this experiment: the quickſilver reſting at its wonted ſtation, if you carefully ſtop the lower orifice under the ſurface of the re-ſtagnant quickſilver, and then lifting up the tube (that which we uſed was about three or four foot long) into the air, keep it well ſtopped; if, I ſay, you firſt depreſs one end and then the other, you ſhall find the quickſilver fall againſt the depreſſed extreme of the tube with ſuch ſwiftneſs and force, as will perhaps ſurprize you, and make you apprehend, that the tube will be either beaten out of your hand or broken: whereas, if unſtopping the tube, whilſt the ſelf-ſame quantity of mercury

remains in it, you let the outward air into the cavity unpoſſeſſed by the mercury, and then if you again ſtop the orifice with your finger, and proceed as formerly, you ſhall perceive the motion of the included liquor to be very much ſlower and leſs violent than formerly, by reaſon of the reſiſtance of the admitted air: which will alſo manifeſtly diſcloſe it ſelf by the conflict and bubbles, that will be produced betwixt the air and quickſilver in their haſty paſſing by one another to the oppoſite ends of the tube.

IF any friend of Mr. *Hobbes*'s, ſeeing the manifeſt inconveniences of this opinion, ſhall on his behalf pretend, that it is what he calls the pure air, that paſſes through the body of the quickſilver to the deſerted part of the glaſs-cane; the anſwer is ready, that Mr. *Hobbes*'s expreſſions look ſo much another way, that his readers (for aught I have found) do generally underſtand him of ſuch common air as is diſplaced by the deſcent of the mercury. And therefore I had reaſon enough to argue againſt what he wrote, as I have newly done; and however, this aſſertion is clearly precarious, and liable to the objections formerly alledged againſt the paſſing of the air through the water. To which we may add this circumſtance, that in our preſent caſe it muſt deſcend into a far heavier and cloſer liquor than water. But perhaps it will be thought, I have already ſaid more than needed againſt an opinion, which has been rejected as well by Pleniſts as Vacuiſts; and though mentioned as to the main by ſeveral writers, as well before Mr. *Hobbes* aſſerted it as afterwards, has been thought ſo unlikely, as not to have been (that I know of) approved by any man, even before the diſcovery of the phænomena of our engine. Which laſt words I add, becauſe that Mr. *Hobbes* not pretending, that any attraction intervenes in the caſe, I ſee not how he can poſſibly make out, to omit other phænomena, the deſcent of the mercury in the tube further and further beneath its wonted ſtation, upon the exhauſtion of the receiver, and the re-aſcenſion of the ſame mercury in the ſame tube, as we pleaſe to let in more or leſs of the outward air; without admitting as much of ſpring or preſſure in the air, as I need contend to have here allowed me. The weight of the terrene particles, by which, at the end of the third expoſition, he is reduced to endeavour the ſolution of the quickſilver's falling lower at the top than at the bottom of a hill, (for I am willing to think, that is his meaning, and that it is by the tranſcriber's fault rather than his, that he reſolutely affirms the quite contrary) will by no means ſerve his turn; it being utterly improbable to imagine, that the contained in ſo little a veſſel as one of our receivers can by its weight counter-balance ſo ponderous a cylinder of quickſilver: whence we may be allowed to argue that the air ſuſtains it by ſuch a preſſure or ſpring as we plead for, whether that proceed from the texture of the aërial particles, or from their motion, or from both.

THE fourth and laſt of Mr. *Hobbes*'s principal expoſitions is of that experiment of ours, wherein 100 and odd pound weight being hung at the depreſſed ſucker, the ſucker was notwithſtanding impelled up again by the air to the top of the cylinder. Of this phænomenon (which has not hitherto proved unwelcome to the virtuoſi) Mr. *Hobbes* gives us the following account.

Hærent hic noſtri: (which, why he ſays, I know not) *quomodo hæc expedies tu?* Page 22.

A. Expedivi ante. Aër enim à retractione ſuctoris retrò pulſus, nec locum in mundo (ut ſupponimus pleno) quò ſe recipiat inveniens, niſi quem ipſe, corpora contigua ſuis locis pellens, ſibi faceret, perpetuâ pulſione in cylindrum tandem cogitur, tantâ velocitate inter cylindri concavam & ſuctoris convexam ſuperficiem, quanta reſpondere ſolet viribus illis magnis, quas ad ſuctorem revellendum neceſſarias experti eſtis. Aër autem ille, quâ velocitate ingreditur, eandem ingreſſus retinet, ſimulque latera cylindri æneï (vi elaſticâ præditi) undiquaque diſtinet. Conatur ergo aër in cylindro vehementer motus contra omnes partes ſuperficiei cylindri concavæ; fruſtra quidem dum ſuctor retrahitur: ſed quamprimum ſuctor manu emiſſus aërem impellere ceſſat, aër ille, qui ante incuſſus erat, propter conatum in omne punctum ſuperficiei cylindri internæ & vim aëris elaſticam, inſinuabit ſe inter eaſdem ſuperficies eâdem velocitate, quâ impulſus fuerat, id eſt, eâ velocitate, quæ reſpondet viribus impulſionis. Si ergo tanta ponderis vis ſuctor iappendatur, quanta manuum vis erat, quâ impellebatur, velocitas, quâ idem aër è cylindro exit, locum in mundo pleno nullum habens quò ſe recipiat, ſuctorem rurſus ad cylindri ſummitatem impellet, propter eandem cauſam quæ effecit, ut ſuctor paulo ante impulerit aërem.

'HERE our men are at a ſtand: How will 'you expedite this difficulty?

'*A.* I have done it already: for the air be'ing beaten back by the retraction of the ſuck'er, and finding no place in the world (which 'we ſuppoſe to be full) where it might diſpoſe 'itſelf, beſides that, which by driving out other 'bodies from their places it may make for it'ſelf, is by perpetual pulſion at length forced 'in the cylinder with ſo great ſwiftneſs, be'tween the concave ſurface of the cylinder and 'the convex ſurface of the ſucker, as may an'ſwer that ſtore of power, which you found 'neceſſary to the drawing back of the ſucker. 'Now the air, with what ſwiftneſs it enters, 'retains the ſame within, and then diſtends 'every way the ſides of the braſs cylinder, 'which is (*of itſelf*) elaſtical. Therefore the 'air in the cylinder being vehemently moved, 'endeavours or thruſts againſt all parts of the 'concave ſurface of the cylinder; but in vain, 'until the ſucker is drawn back. But as 'ſoon as the ſucker, having ſlipt the hand, 'ceaſes to make its impulſe upon the air, that 'air, which was before driven in, by reaſon of 'its endeavour againſt every point of the inter'nal ſuperficies of the cylinder and of the elaſ'tical force of the air, will inſinuate itſelf be'tween the ſame ſurfaces with the ſame ſwift'neſs, as that by which it was impelled, that is, 'with that velocity, which anſwers the ſtrength 'of the impulſion. If therefore ſo great a

'power

'power of weight be hung upon the ſucker, as 'may anſwer the power of the hands by which 'it was impulſed; the ſwiftneſs, with which 'the ſame air goes out of the cylinder, finding 'no place in the world (which is full) where to 'diſpoſe itſelf, will again impel the ſucker to 'the top of the cylinder, for the ſame reaſon, 'that the ſucker a little before made an im-'pulſe upon the air.' Thus far our author's paſſage; againſt whoſe ſolution it is eaſy to draw divers arguments, from what we have diſcourſed againſt the firſt of his four explications. But though we refer you thither, yet we will here alſo obſerve, that this whole conceit of the air's running in and out with ſtrange velocity between the ſucker and the cylinder is precarious; nor does he propoſe any one phænomenon to countenance it. To which general advertiſement I ſhall add the three following particulars. Firſt, that in an engine, ſo contrived, that the pump lay covered with water, when the ſucker was retracted, the atmoſphere would ſtrongly preſs the water againſt it; and, if the manubrium were let go, would ſwiftly enough repel up the ſucker into the deſerted cavity of the cylinder. Which being a caſe parallel to that under conſideration, let any unbiaſſed perſon judge, how likely it is, that the air could perform all theſe excurſions without exciting bubbles, notwithſtanding the water's conſtant interpoſition betwixt it and the cylinder. Secondly, that there is as little probability in what our author teaches in thoſe words *conatur ergo aër*, &c. I might here repeat what we formerly mentioned of the breaking of our receivers inwards, not outwards; and I might add, that I ſee no reaſon, why the conatus of the included air, if its conatus were granted, ſhould be fruſtraneous, when the ſucker is depreſſed. But I will rather demand, why, if the air within have ſo ſtrong an endeavour outwards, as to ſtretch the thick ſides of the braſs cylinder, as Mr. *Hobbes* (with what probability, let any man judge) would have it; I demand, I ſay, why this air does not throw out the wooden peg or valve, which we have often to our trouble ſeen thrown out with great force and noiſe, when the depreſt ſucker being thruſt up again, while there was air in the cylinder, we forgot to leave the valve open; though in this caſe the air, that drove out the peg, was far enough from ſtretching the cylinder. And I further demand, how it comes to paſs, that, if having ſtopt the hole of the cylinder with your finger inſtead of the peg, you ſwiftly depreſs the ſucker, you ſhall be ſo far from feeling a preſſure outwards againſt the pulp of the finger from any thing contained in the cavity of the cylinder, that your finger will be ſtrongly, and perhaps not without ſome pain, preſſed in by the ambient air; in ſo much that it was this phænomenon, and one ſomewhat like it in the Torricellian experiment, that ſeem to have ingaged my other adverſary, the learned *Linus*, to maintain a conceit quite contrary to Mr. *Hobbes*'s, and imagine in the deſerted cavity of the cylinder, not a diſtending, but violently contracting ſubſtance. Thirdly, That as to the laſt part of the paſſage under conſideration, beginning at *ſi ergo*, &c. which ſeems to me ſomewhat intricate; I do not ſo clearly underſtand, why the air, that is impelled in ſo ſwiftly betwixt the cylinder and the ſucker, ſhould not reſiſt the ſwift egreſs Mr. *Hobbes* aſcribes to the included air by the ſame paſſage: nor why this impelled air, that has ſo ſtrong an endeavour outward, ſhould never depreſs the ſucker (againſt whoſe upper part it muſt bear as well as againſt the cylinder) as well as the ſame air, diffuſing its motion through the vaſt ambient medium, can enable the external air to thruſt up the ſucker again; eſpecially, ſince during ſuch a depreſſion of the ſucker (as we have mentioned not to happen) made by the rebound of the air, forcibly impelled in from the cloſe bottom of the cylinder, the air from without may all the while, with congruity enough to Mr. *Hobbes*'s principles, get in between the ſaid ſucker and the cylinder. But not to inſiſt upon theſe niceties; I ſay, that the lifting up of the ſucker either is not neceſſary to prevent a vacuum; or that in ſome caſes it will be hard to ſhew, how a vacuum can by Mr. *Hobbes* be avoided. For when the depreſt ſucker is ready to be thruſt up again, if you hang a ſomewhat greater weight at it than an hundred and odd pounds, it ſhall not be lifted up at all. And I ſhall make this further improvement of the experiment under conſideration, that whereas this progreſs and regreſſion of the impulſe of the external air cannot reaſonably be ſuppoſed to be very laſting, you may, by a competent weight, detain the ſucker depreſt, till the ambient air is as quiet as it uſes to be; and yet if then you take off the overplus of weight, and perhaps a little more, in caſe the pump have been very ſtanch, the ſucker and the great weight appended will, notwithſtanding, be carried up; which it is no way likely it could be by the impulſe of the outward air, which had time to decay and be confounded. And as for the inward air, beſide that we have proved, that it has no ſuch conatus outwards as Mr. *Hobbes* pretends, why ſhould not that, were it granted, throw out the ſucker rather than cauſe it to be impelled inward; it being no way likely, that in caſe ſome air ſhould get out of the cavity of the cylinder, it could ſo move the outward air, as that the reflex of that impulſe ſhould make that free outward air bear more ſtrongly againſt the outſide of the ſucker than the inſide of the ſame ſucker is preſt againſt by the included air, whoſe *impetus* is incomparably leſs diffuſed? But not to be thought a more nice and diligent opponent than the matter requires, I ſhall drive this diſcourſe no further, but rather deſire it may be obſerved in general, that whatever be reſolved to be in the cavity of the cylinder when the ſucker is depreſt, yet ſince it is manifeſt, that it is at leaſt, in great part, devoid of common air; and ſince the ſucker, with the appended weight may, if the inſtrument leak not, be impelled up, when, in all probability, thoſe forced undulations of the air, that may be ſuppoſed to have been made by the ſucker, have ceaſed; the Carteſians, Mr. *Hobbes*, and thoſe

others

others, that will not have recourſe to the unintelligible attraction of ſome rarefied ſubſtance within, muſt aſcribe ſo ſtrange a phænomenon to the preſſure of the air without. But I ſhall no further preſs this fourth objection, partly becauſe it is added to the other three, only *ex abundanti*, and partly becauſe this chapter is grown ſo long already.

I KNOW indeed that after the expoſition laſt recited out of Mr. *Hobbes*, he makes the Academian Dialogiſt confeſs, that the reſt of the phænomena of our engine may alſo not uneaſily be reduced to his principles. But perhaps they, that take notice of the variety of thoſe phænomena we have have ſet down in our treatiſe, will ſcarce be of his mind; and thoſe, that have conſidered what has been diſcourſed in this chapter againſt his four principal explications, and what I am about to ſubjoin in the following part of this treatiſe, concerning divers other ſolutions that he gives, will perhaps be inclined to think, that others may be like theſe, without being therefore neceſſarily true.

CHAP. V.

In which divers ſcattered explications, and other paſſages in Mr. Hobbes's *Dialogue, are examined.*

I PROCEED then to the fifth chapter, in which and the next I glean up and examine divers ſcattered paſſages, wherein he offers at ſomewhat, by way of argument, againſt ſome things we had delivered in our epiſtolical treatiſe: I ſay, what he offers by way of argument; for as to thoſe paſſages, that do but either praiſe himſelf or diſparage his adverſaries, I have almoſt as little leiſure as inclination to take notice of them, and do not much apprehend that the virtuoſi (eſpecially ſuch as know us both) will think what I write the leſs rational for being civil; or will let me ſuffer, in their opinions, for neglecting to trouble them, in a philoſophical controverſy, with matters, that do but very little belong to it.

TO ſkip then what Mr. *Hobbes* is pleaſed to ſay, in the firſt page of his Dialogue, concerning ſome diſputable diſcoveries about ſenſation, which he challenges to himſelf; and to paſs by divers other things in the ſecond or third following pages, which relate to him, or to the ſociety he writes againſt, rather than to the nature of the air; we ſhould begin with the opinion he thinks fit, in the fifth page, to impute to us, as if we diſtinguiſhed what is fluid from what is not ſo, only (for ſo his ratiocination imports) by the bigneſs of the parts of which a body conſiſts: but deſigning, in an Appendix to be ſubjoined to this diſcourſe, to examine what I find in this Dialogue diſperſed touching fluidity, I ſhall now only ſay, that he does very much miſtake and miſrepreſent my doctrine of fluidity; wherein I expreſly teach, that the principal cauſe or condition of it is not the ſize, but the motion of the ſmall parts that compoſe the fluid body.

TO take up then the particulars we are to examine, in the order (as far as conveniently may be) wherein I find them lie in the author's Dialogue, and paſſing by at preſent thoſe things, which either we have conſidered already, or are not to conſider in this place; the firſt particular, that offers itſelf to be taken notice of, is this paſſage at the bottom of the twelfth page:

B. *In vas apertum infudimus aquam, in aqua* Page 12. *fiſtulam ſtatuimus erectam, longam, exiliſſimam; obſervavimus autem aquam è vaſe ſubjecto in erectam fiſtulam aſcendiſſe.*

A. *Nec mirum; nam ſuperficiem aquæ, particulæ aëri interſperſæ aquæque contiguæ motu ſuo verberabant, ita ut aqua non potuit in fiſtulam non aſcendere, & ſenſibiliter quidem in fiſtulam valde anguſtam.*

'*B.* We poured water into an open veſſel; 'we placed in the water a long ſtreight, ſlender 'tube; and we obſerved, that the water did 'aſcend from the veſſel underneath into the 'erected tube.

'*A.* No wonder: for the ſmall particles, that 'are interſperſed in the air near the water, did, 'by their motion, beat upon the ſurface of the 'water, ſo that the water muſt of neceſſity 'aſcend into the pipe, and that ſenſibly into 'a pipe, that was ſo exceeding ſlender.'

TO this I ſay, that it is manifeſt, by what I write in my epiſtle, that I did not then take upon me, nor do I undertake in this place, to aſſign the true reaſon of the propoſed phænomenon. An attempt of this kind has been ſince addreſſed to me, which being ingenious, if not alſo true, may be conſulted. In the mean time I cannot but declare, that I am no way ſatisfied with Mr. *Hobbes*'s expoſition: for, to ſay nothing of the motion he aſcribes to the particles diſperſed through the air, he leaves the difficulty unſolved, ſince there being common air as well within the cavity of the ſlender pipes as without it, he neither ſhews, nor ſo much as offers at, a reaſon, why the preſſure of the air within ſhould not reſiſt the preſſure of the ſame kind of air without; as we ſee it does in greater pipes. And poſſibly he would have paſt by this particular, if he had not overlooked the advertiſement I gave towards the cloſe of the 35th experiment; that it would concern thoſe, who ſhould undertake to ſhew the cauſes of this phænomenon, to bethink themſelves alſo of a reaſon, why, if the experiment be tried with quickſilver inſtead of water, the ſurface of the liquor will, inſtead of being higher, be lower within the pipe than without it. Whereas if Mr. *Hobbes*'s explication be ſufficient, why ſhould not the contrary happen in quickſilver as well as in water?

THE next paſſage I have to conſider is in the 13th page, thus ſet down: *Siquis poſt im-* Page 13. *pulſionem revulſionemque ſuctoris aliquoties repetitam, epiſtomium ſuperni orificii recipientis conetur extrahere, inveniet illud valde gravitare, tanquam ſi multarum librarum pondus ab eo penderet. Unde contingit hoc?*

A. *Ab aëris, qui eſt in recipiente fortiſſimo conatu circulari facto à violento ingreſſu aëris inter ſuperficiem ſuctoris convexam & cylindri concavam, generato per iteratam illam impulſionem revulſionemque ſuctoris, quam vos perperam vocatis exſuctionem aëris. Nam propter naturæ plenitudinem,*

nitudinem, epiſtomium extrahi non poteſt, quin aër qui eſt in recipiente (epiſtomio contiguus) una extrahendus ſit. Qui quidem aër, ſi quieſceret, facillimè epiſtomium ſequeretur: ſed dum velociſſimè circuit, ſatis difficulter ſequitur; id eſt, videtur eſſe valde gravis.

B. *Veriſimile eſt: Nam ut aër novus in recipiens paulatim admittitur, etiam apparentem illam gravitatem paulatim perdit.*

'If any one after the frequently-repeated impulſe and retraction of the ſucker, endeavour 'to draw out the ſtopple of the upper orifice 'of the receiver, he ſhall find it gravitates very 'much, as if a weight of many pounds hung 'upon it. Whence comes this?

'*A.* From a ſtrong circular endeavour of 'the air within the receiver, made by the vi'olent ingreſs of the air between the convex 'ſurface of the ſucker and the concave of the 'cylinder, procured by the repeated impulſe 'and revulſion of the ſucker, which you im'properly call the exſuction of the air. For 'by reaſon of the fulneſs of nature the ſtopple 'cannot be drawn out, but the air that is in 'the receiver (contiguous to the ſtopple) muſt 'be drawn out too: which air, if it were ſettled 'and at reſt, the ſtopple would eaſily be drawn 'out; but whiles that does moſt ſwiftly cir'culate, it comes out very hardly, that is, it 'ſeems to be very heavy.

'*B.* Very likely: for as ſoon as freſh air is 'by degrees let into the receiver, it likewiſe 'by degrees loſes this ſeeming gravity.'

But, I do not much fear, that this explication will keep the experiment from continuing to be thought, by ingenious men, a notable confirmation of our hypotheſis. For, to paſs by ſomething, that, though I am no way ſatisfied with, cannot well be examined in few words; I anſwer, firſt, that if there be ſuch a vehement circular endeavour, as he imagines, of the air in the receiver, by which motion he elſewhere teaches (as we have ſeen above) that the air ruſhes out with violence enough to make the atmoſphere lift up in our cylinder above an hundred pound weight; I ſee not, why it ſhould not rather throw out the ſtopple under conſideration, than hinder its extraction. And I ſee not why, when the external air is re-admitted at the ſtop-cock into the exhauſted receiver, and thereupon there does ſenſibly follow for a little while a whirling about of the included air, the ſtopple, that juſt before ſeemed ſo much to reſiſt the being drawn out, ſhould ceaſe to make any ſuch reſiſtance. Nor do I ſee, how the plenitude of nature ſhould, as is here intimated, hinder the extraction of the ſtopple; for, according to the Pleniſts, the world and the receiver muſt be at all times equally full. And if the contiguous air muſt for Mr. *Hobbes*'s reaſon neceſſarily be extracted with the ſtopple in one caſe, I ſee not, why the like ſhould not happen in another. But ſince Mr. *Hobbes* is pleaſed to call us experimentarian philoſophers, let us ſhew, that ſuch explications as theſe of his need not make us aſhamed of the name. I ſay then, that it appears by our experiments, that there is no ſuch *fortiſſimus conatus circularis* in the exhauſted receiver as he pretends; but that there is indeed an endeavour of the ambient atmoſphere to preſs inwards the parts of the glaſs and cover, that are contiguous to it. For, as I have alſo noted already, a light bladder ſuſpended in the cavity of the receiver betrayed no ſuch motion as Mr. *Hobbes* here ſuppoſes. To which I ſhall now add, that neither were a pair of ſcales ſuſpended within the ſame cavity; nor was a long magnetical needle, that reſted upon the point of another needle, at all whirled about by this imaginary motion of the air. Beſides, if you leiſurely looſen the braſs ſtopple, ſo that it may be very near, but not contiguous, to the ſides of the ſocket, you ſhall manifeſtly perceive a ſtrong current of air to flow into the receiver at that paſſage: and more than once, when inſtead of that piece of braſs we ſtopt the hole in the cover with our cement, one might obſerve, ſometimes whilſt we were pumping, ſometimes after we had done pumping, that the outward air by degrees depreſſed the ſuperficies of the cement expoſed to it, and made it concave, and now and then would break through it, thruſting it inward with great violence and noiſe.

In the ſame page our author rectifies, after his way, another of our explications in theſe words; *Vidimus item aquam demiſſam in recipiens poſt ſuctoris aliquot reciprocationes ita bullire, ac ſi ſuppoſito igne ferveſceret.* Page 13.

A. *Id quoque accidit propter velocitatem aëris, ut dictum eſt, in recipiente circumeuntis; niſi forte aquam illam dum bullit calidam quoque eſſe deprehendatis. Nam ſi certi eſſemus illam caleſcere, alia cauſa phænomeni excogitanda eſſet.*

B. *Imo certi ſumus, quod non caleſcit ſenſibiliter.*

A. *Quid ergo tali aquæ motui conferre poſſe putas majorem vel minorem atmoſphæræ gravitatem?*

B. *Neque illum motum attribuunt, puto, atmoſphæræ.*

'We ſaw alſo water, being let down into 'the receiver, after ſome returns of the motion 'of the ſucker, to bubble ſo as if it had boiled 'over a fire.

'*A.* This likewiſe happens, as we ſpake, by 'reaſon of the ſwiftneſs of the circulating air; 'unleſs perhaps you find the water hot too 'whilſt it bubbles. For if we were ſure it was 'hot, we muſt find out ſome other cauſe of 'the phænomenon.

'*B.* We are certain it is not ſenſibly hot.

'*A.* In what therefore can the greater or leſſer 'motion of the atmoſphere promote ſuch a 'motion as this?

'*B.* I ſuppoſe they do not attribute this 'motion to the atmoſphere.'

But, I confeſs, I ſee not, how the circular motion of the air within the receiver could in a phial with a long neck produce ſuch effects as in my epiſtle are recited; eſpecially I ſee not, how ſuch a wind paſſing along the ſurface of the water could raiſe ſo many and ſo ſtrangely big bubbles, which ſeemed many of them to riſe from the lower parts of the water, and ſwelled notably as they aſcended; and how ſuch a wind ſhould carry up the moſt part of the water through the long neck of the phial, and as it were ſpout into the receiver.

As for what he ſays about the gravity of the atmoſphere, it is plain enough, that my conjecture aſcribes the phænomenon to the taking off, not the gravity of the external air, but of the preſſure of the air within the receiver; though I ſee not why the removal of the weight of the atmoſphere, if it could be out of the engine effected, ſhould not have a like operation.

AND (to anſwer Mr. *Hobbes*'s queſtion as it ſhould have been put) that, which I think the greater or leſſer preſſure of the air confers to this phænomenon is this; That whereas common experience ſhews us, that water by being heated is expanded, and has bubbles generated in it; and whereas our former experiments, eſpecially the 28th, have made it appear, that there is wont to be in water and other liquors aërial particles, which tend to expand themſelves, and do actually do ſo, in numerous bubbles, when the preſſure of the incumbent air is conſiderably leſſened: in the preſent phænomenon, that preſſure being, by the exhauſtion of the receiver, taken off, the aërial particles and agitated vapours, that abound in the hot water, are allowed to expand themſelves, as before they could not, and to make ſuch numerous and great bubbles, that thereby a good part of the water is carried out of the phial. So that I ſomewhat wonder, what makes Mr. *Hobbes* ſpeak, as if there were no ſenſible heat of the water under conſideration, ſince it is expreſly ſaid, that it was put in hot; and if it were put in cold, could by no pumping be brought to the leaſt ſhew of efferveſcence. And as for his explication of the phænomenon, the experimentarian philoſophers need not the objection lately made againſt it; for I have already evinced by experiments, that there is in our exhauſted receivers no ſuch peculiar motion of the air as he aſcribes the phænomenon to; nay, when there is manifeſtly a whirling about the air in the glaſs upon the admiſſion of the external air, the production of numerous bubbles in the water preſently ceaſeth. And therefore I ſee not, why Mr. *Hobbes* might not have let alone my conjecture, (for I propoſed it, and look upon it, as no more) unleſs he could either have diſproved it better, or ſubſtituted a more probable one than he has in its place.

Page 3. As for what he adds in theſe words, *Ab hoc experimento manifeſtum eſt, quod recipiens per exuctionem hanc quam vocatis aëris, non ſit vacuum. Nam moveri aqua non potuit niſi à movente aliquo moto & contiguo. Itaque phænomenum hoc demonſtrationem ſuppoſitionis meæ continere videtur non infirmam:* 'It is manifeſt from this 'experiment, that the receiver is not made 'empty by this exſuction of air, as you call it: 'for the water could not be moved but by 'ſome contiguous mover, that was it ſelf in 'motion: Therefore this phænomenon ſeems 'to contain no weak demonſtration of my 'hypotheſis:' I am not obliged to anſwer it, but leave that to thoſe, that are profeſt Vacuiſts; againſt whom I muſt doubt whether his ratiocination will conclude, though the conſequence be not manifeſt to me. For himſelf allows his terreſtrial atoms an innate circular motion, which conſequently needs not depend upon ſome body contiguous and moved; and the Vacuiſts will ſay, that the particles of the water being ſtrongly agitated, when it was put into the receiver (whether by fiery corpuſcles ſwarming in it, or otherwiſe) and the reſiſtance of the incumbent air being taken off, the phænomenon would be produced juſt as it is, though we ſhould ſuppoſe no other body to ſucceed in the room of the exhauſted air. And beſides, though ſome ſubtile particles of active matter ſhould get in, to agitate the aqueous and aërial corpuſcles, yet (they may ſay) there is no neceſſity, that ſuch minute particles ſhould be numerous enough to fill up exactly all the little ſpaces deſerted by the air. And even upon this ſuppoſition, as it would not follow, that ſuch relinquiſhed ſpaces were all of them quite empty; ſo would not the phænomenon at all prove, much leſs manifeſtly prove, that they were quite full. And ſince an actual heat, that is, a briſk and various agitation of its ſmall parts, is requiſite to the boiling of the water in this experiment; perhaps others will not think it more abſurd, that the removal of the preſſure of the air ſhould occaſion this expanſive motion in the water, than that, which Mr. *Hobbes* muſt allow, that in air compreſſed by quickſilver, or ſome other weight, the removal of that preſſure is ſufficient to make that air expand it ſelf by the flying abroad of its parts.

AND whereas Mr. *Hobbes* urges this other argument againſt the Vacuiſts, *Præterea, dic mihi, bullientem aquam potuiſtin' conſpicere?* *Page* 13, 14.

B. *Quidni?*

A. *Nonne viſionem fieri concedunt veſtri per actionem continuam ab objecto ad oculum? Nonne etiam putant actionem eſſe motum, & omnem motum eſſe corporis? Quomodo ergo potuit ab objecto, nempe aqua, ad oculos tuos motus per vacuum (id eſt, per non corpus) derivare?*

B. *Non affirmant noſtri ita vacuum eſſe recipiens, ut nullus omnino aër relictus ſit.*

A. *Nil refert an totum recipiens vacuum ſit, an magna ejus pars; nam utrumvis ſupponatur, derivatio motus ab objecto ad oculum intercipietur.*

B. *Ita videtur, nec habeo quod reſpondeam.*

'Beſides, tell me, could you ſee the water 'bubbling in that manner?

'*B.* What elſe?

'*A.* Do not your aſſociates grant, that viſion 'is made by a continued action from the ob-'ject unto the eye? Do they not alſo think 'action to be motion, and all motion to be 'of ſome body? How therefore could the mo-'tion be derived from the object, the water, 'unto your eyes through a vacuum, that is 'ſomewhat, that is not a body?

'*B.* Our friends do not affirm the recipient 'to be ſo empty, that no air at all is left.

'*A.* No matter, whether the receiver be 'wholly, or for the greater part empty; for 'which-ever you ſuppoſe, the derivation of 'the motion from the object to the eye will 'be intercepted.

'*B.* It may be ſo; I cannot tell what to anſwer.'

The Vacuiſts will perhaps anſwer him, as I anſwered *Franciſcus Linus* to an almoſt like objection. And thoſe of them (which make far the greateſt number) who plead

but

but for an interſperſed vacuum, will perhaps tell him, that they take viſion to be made, not by ſuch a propagation of impulſe as he does, but by a trajection of effluvia, that iſſuing out of the ſun, and traverſing the diaphanous bodies interpoſed, rebound from the object to the eye. And according to this doctrine they may aſk Mr. *Hobbes*, why a motion may not be made through a vacuum or *non corpus?* Nay, how it can naturally be ſtopt *in vacuo*, where there is nothing to reſiſt it? But controverſies of this nature it lies not upon me to proſecute.

In the 14th page, Mr. *Hobbes* having recited that experiment of ours, of killing animals included in our receiver by the exhauſtion of the air in two or three minutes of an hour, ſubjoins
Page 14. theſe words; *Credin' tu animalia iſta tam cito interempta eſſe eo quod carerent aëre? Quomodo ergo ſub aquam vivunt urinatores, quorum aliqui (aſſueti à pueritiâ) caruere aëre per horam integram? Incluſa in recipiente animalia occidit motus ille idem vehementiſſimus, quo diſtenduntur rumpunturque incluſæ veſicæ.* 'Do you think 'theſe animals were therefore ſo quickly killed, 'becauſe they wanted air? How then do they, 'who make a trade of diving, live under water, 'of whom there be ſome, who being accuſtom-'ed from their childhood, have wanted air a 'whole hour? No, that moſt vehement motion, 'by which bladders ſhut therein are diſtended 'and broken, kills theſe animals ſhut up in 'the receiver.' But, though he ſays no more in this place concerning this matter, yet it ſeems he either much liked his own conjectures, or greatly diſliked mine, ſince in his epiſtle dedicatory to the learned *Sorberius* he ſingles out this ſole phænomenon to explicate; *Ego contra* (ſays he there) *neque aërem exugi poſſe, neque incluſum animal (etſi exuctus eſſet) tam cito moriturum eſſe exiſtimo. Actio quidem, quam mors illa ſequitur, videri poteſt vel ſuctio quædam (& propterea exſuctione concluſi aëris interfici animal, reſpiratione ſublatâ) vel etiam compulſio aëris ab omni parte verſus centrum ſphæræ, cui animal includitur; & ſic videri poteſt mori à tenacitate compreſſi aëris, quaſi aqua ſuffocatum; nimirum hauſtum in intima pulmonum aërem ſolito tenaciorem, inter arteriam & venam pulmonis, curſum ſanguinis intercipiendo ſiſtere.* 'I, 'on the contrary, think, that neither the air can 'be ſucked out, nor that the animal would ſo 'ſoon die, if it were ſucked out. The action 'indeed, to which this death is a conſequent, 'may ſeem either a certain ſuction (and ſo, 'that the animal is killed by the exſuction 'of the included air, its reſpiration being taken 'away) or a compulſion of the air from all 'parts towards the centre of the ſpherical glaſs, 'in which the animal is incloſed, and ſo may 'be ſeen to die ſtifled by the tenacity of the 'compreſſed air, as it were, with water; the 'air more tenacious than uſual being drawn 'into the inwards of the lungs, and there, be-'tween the pulmonary artery and vein, ſtop-'ping the courſe of the blood.' But, as I propoſed by conjecture doubtingly, and profeſs my ſelf to be in a further inquiry about the uſe of the air and of reſpiration; ſo I muſt ſtill think, that we want ſome further or clearer diſcovery about that matter, notwithſtanding what has been delivered concerning it by Mr. *Hobbes*. For his argument againſt my conjecture is, in the paſſage that propoſes it, anſwered by himſelf: for he plainly intimates, that divers, who can live without air (which yet I might queſtion, if he means without any air at all) for a whole hour, are accuſtomed to it from their childhood. Wherefore, unleſs the animals, that died in my engine, had been for a long time framed by degrees to live without air, it will not follow, that the want of it could not diſpatch them in a ſhort time, as ordinary men may be drowned in a few minutes. And having purpoſely let down ſome mice and ſmall birds into a deep glaſs filled with water, and kept them from emerging by a weight tied to their legs or tails, though ſome lived longer than others, yet I obſerved them to be killed faſt enough to keep my conjecture from being incredible: eſpecially the laſt we made trial of, though a large and luſty mouſe, appeared to be quite dead within ſomewhat leſs than one minute, meaſured by the vibrations of a pendulum. And we particularly took notice, that, before drowning, divers bubbles, which ſeemed to be the reſpired air, came out of their mouths, and aſcended through the water.

And as for the explication, that Mr. *Hobbes* would recommend inſtead of mine, not to urge, that I could wiſh he had been pleaſed to ſhew us, how the tenacious air he imagines to be inſpired comes to produce thoſe ſtrange convulſions, and other ſymptoms mentioned in my epiſtle; not to urge this, I ſay, we have already diſproved the ſuppoſition his opinion is built on, namely, that there is in the exhauſted receiver ſuch a *motus vehementiſſimus*, as he pretends: beſides that he ſhews not how this motion comes to kill the included animals, which I was wont to keep, not near the centre of the receiver, where he ſeems to think this motion moſt operative, but near the bottom of it, that the included animal might have ſomething firm under his feet. Nor does it at all clear the difficulty, that he would have this motion the ſame, whereby included bladders are diſtended and broken. For, beſides that it is very hard to conceive, how the tenacity of the air, or its beating from all parts upon the convex ſurface of an almoſt quite empty bladder, (for in ſuch alſo the experiment he refers to will ſucceed) ſhould make it burſt outwards; beſides this (I ſay) we have already proved, that the diſtenſion, and breaking of bladders in our receiver, proceeds not from any ſuch motion of the neighbouring air as is here preſumed, but from a quite differing, if not from a contrary cauſe.

In the ſame page our author makes a digreſſion from the engine, and diſcourſes of another experiment, which I have long ſince often made. But though his explication be liable enough to juſt exceptions, (as I can make good, if it be required) yet becauſe the experiment is none of thoſe I delivered, I ſhall leave it to be examined by others. And for the ſame reaſon I forbear to meddle with that he has in the next page concerning the wind-gun. As to what

what he has in the ſame 16th page, in theſe
Page 16. words; *Placet mihi tua magis hypotheſis quam illa de vi aëris elaſtica: nam video, quod à veritate illius veritas dependet vel vacui vel pleni; ſed à veritate hujus nihil ſequitur in neutram partem quæſtionis. Aëris, inquit, ſtructura ſimilis eſt compreſſæ lanæ. Bene eſt. Lana fit ex filis. Recte. Sed cujus figuræ? Si parallelopipedi, nulla poteſt eſſe compreſſio partium: ſi non parallelopipedi, erunt inter fila illa ſpatia quædam relicta; quæ, ſi vacua ſunt, ſupponunt vacuum, ad probandum, quod vacuum eſt poſſibile; ſi plena, plenum dicunt quod vacuum putant:* 'Your hypotheſis 'pleaſes me better than that of the ſpring of 'the air: for from its truth depends the truth 'of a vacuum or a plenum; but from the truth 'of that, nothing follows on either part of the 'queſtion. The make of the air (ſays he) is 'like that of compreſſed wool. Well; wooll 'is made of hairs or threads. Right; but of 'what figure? If of a parallelopipedon, there 'can be no compreſſion of parts; if not of a 'parallelopipedon, there will be betwixt the 'hairs certain ſpaces left, which if they be 'empty, they ſuppoſe ſome place empty, to 'prove that a vacuum is poſſible; if full, they 'ſay that is full, which they ſuppoſe to be 'empty:' To this paſſage, I ſay, I cannot but repreſent, that the queſtion is not, whether from the hypotheſis, that aſcribes a ſpring to the air, depends the proof of a vacuum or a plenum, but whether the hypotheſis it ſelf be true or no. For, ſure there are many things certain in natural philoſophy, from whoſe truth that of a plenum or a vacuum cannot be deduced. And to what he adds concerning the ſtructure of the aërial particles, the Vacuiſts may tell him, that they make no ſuch argument as he is pleaſed to make for them; and do not commonly imploy the figure of the aërial particles to prove a vacuum, but other arguments, ſuch as Mr. *Hobbes* has not yet well anſwered: and having by them, as they judge, proved interſperſed vacuities, they might without inconvenience ſuppoſe in an aërial corpuſcle little empty pores, upon whoſe account it may be capable of compreſſion, in caſe they ſhould think fit (which I know not that any of them does) to aſſign it the figure of a parallelopipedon. But this controverſy the Vacuiſts may, if they pleaſe, proſecute. In the ſame page Mr. *Hobbes* begins, and in the next he continues, a long diſcourſe concerning the going out of fire in our receiver upon the exhauſtion of the air: the paſſage is too prolix, and does too little concern the ſpring of the air to be here totally tranſcribed, or examined period by period. In ſum, he endeavours to do two things: the one is to reduce what happens to kindled coals placed in our engine to what happens in certain mines, wherein when ſome thick damps aſcend, both charcoals and candles are ſoon extinguiſhed thereby: the other is to ſhew, that by the reciprocation of the ſucker, the air impelled firſt into the cylinder, and then into the receiver, is put into ſuch a motion, as gives it a certain middle conſiſtence, as he ſpeaks, betwixt the conſiſtence of pure air and that of water. But I ſhall not need to examine this ſecond part of his diſcourſe, becauſe I deny the firſt; and being able to diſprove the thing it ſelf, namely, the thickneſs of the air in the exhauſted receiver, I need not ſpend time about what he teaches *de modo*.

To examine then only the firſt of the above-mentioned particulars, I ſhall begin with obſerving, that his ſtory of the damp to be met with in mines is more largely ſet down by Mr. *Hobbes* in that chapter of his Elements of Philoſophy, where he treats of gravity; in which place he ſeems to mention it (to uſe his own expreſſion) as a ſtory of doubtful credit, which it is not like he would have done, if he had then ſeen it. Which I mention, not that I deny the ſtory for the main, nor that I would bring Mr. *Hobbes* into a ſuſpicion of relating things untrue as matters of fact, his enemies themſelves having not accuſed him of ſuch a meanneſs; but becauſe, if he have not ſince obſerved the thing himſelf, there may eaſily be a miſtake in ſome of the circumſtances; as for inſtance, the number of minutes, wherein the thick air choaks the fire: and it is upon that circumſtance, that the validity of what he deduces from the obſervation chiefly depends. But, however the matter fare with theſe ſubterraneal damps, we have already proved by ſeveral of the experiments of our engine, that in the exhauſted receiver there is no ſuch motion of the air as is here ſuppoſed. And it may be ſufficiently proved, that whatever remains in the receiver is not ſuch a ſubſtance as Mr. *Hobbes* would have it; for that, he here tells us, is of a conſiſtence betwixt air and water; and in the above-cited place of his Elements he ſays, that it is not much lighter than water. But by the Magdeburgick experiment (we have already had occaſion to mention two or three times) it is evident, that the receiver, by being exhauſted of common air, is ſo far from growing heavier, much leſs ſo much heavier as it muſt, if it were filled with a ſubſtance not much lighter than water, that it loſt above an ounce of its former weight. And to this agrees what we ſee happen in æolipiles, that grow lighter, when the air is expelled. Beſides, if the receiver be in our preſent caſe filled with a ſubſtance, whoſe conſiſtence is ſo much nearer that of water than is our common air, as Mr. *Hobbes* would have it; how chance a pendulum ſhould not move very ſenſibly ſlower in it, when in water the diadromes are ſo exceedingly much more ſlow? And the breaking of an hermetically-ſealed bubble in our receiver outwards, when the air was much exhauſted, and not before, together with divers other experiments that might be eaſily applied to this purpoſe, in our epiſtle, do ſufficiently evince, that it is not a thicker and far heavier air, but a more yielding and lighter, that remains after pumping in the cavity of our receiver.

AND thus much as to Mr. *Hobbes*'s diſcourſe upon our experiment. But as for the thing itſelf, it appears, that when I related it, I thought it might admit a further inquiry: and indeed there may be ſo many ways of extinguiſhing fire (as we ſee that the flame of a candle may be blown out

by the wind, or quenched in water, or put out by the compreſſion of a pair of ſnuffers, or ſuffocated for want of air to receive its fuliginous ſteams, or (if that be a different way) ſtifled by the thick exhalations of deep mines or of new wine) that as it is not in all caſes ſo eaſy to aſſign the true cauſe of the extinction of fire; ſo it is unſafe to conclude with Mr. *Hobbes*, that becauſe a candle or a live-coal may, a great way under ground, be extinguiſhed by a thick damp, therefore the effect muſt proceed from the like cauſe in our receiver, where there is no ſign of any damp or unuſual thickneſs of the air, but of the contrary.

But let us follow Mr. *Hobbes* to the next paſſage, wherein he ſeems fond enough of playing the cenſor. For, ſpeaking of our 11th experiment, wherein the coals, that ſeemed almoſt dead in our exhauſted receiver, being taken out into the air began to ſhine again, having made his academian dialogiſt ſay, *Fuere eorum aliqui, qui remanſiſſe dixerunt in carbonibus illis (quanquam extincti videbantur) particulas quaſdam igneas, quæ, admiſſo aëre, ventilatæ cæteram molem denuo accenderent:* 'There were 'ſome of them, that ſaid there remained in 'thoſe coals (though they ſeemed extinguiſhed) 'ſome fiery particles, which, being blowed up 'by the air, upon its admiſſion did re-kindle 'the reſt of the maſs.' The other (by whom Mr. *Hobbes* is meant) anſwers him, *Næ illi quæ dicerent non videntur cogitaſſe, ſed ſortitos eſſe.* 'In good faith they ſeem not ſo much 'to have conſidered what they ſhould ſpeak, 'as to have taken it up at all adventures.' This is very ſevere. But let us ſee what weighty reaſon he has to be ſo: *Credin' tu in carbone ignito partem aliquam non carbonem, ſed ignem eſſe; aut in candente ferro partem ineſſe, quod ferrum non ſit, ſed ignis?* 'Do you believe, 'that in a kindled coal, there is any part, 'which is not a coal, but fire; or in a red-hot 'iron, there is any part, that is not iron, but 'fire?' But ſome will think, that by theſe words, he does rather propoſe than prove his opinion: wherefore let us hear his ratiocination, which he annexes in the following words: *Ab unica ſcintilla magnæ urbis incendium naſci poteſt. Atqui ſi ignis corpus ab ignito diverſum ſit, non plures potuere eſſe partes ignëæ in toto incendio, quam in una illa ſcintillula. Videmus corpora diverſorum generum à luce ſolis tam per refractionem quam reflectionem factam in ſpeculis comburentibus accendi poſſe: neque tamen quenquam eſſe credo, qui putet particulas igneas à ſole ejectas tranſire poſſe per ſubſtantiam globuli cryſtallini. In aëre intermedio ignis nullus eſt.* 'A great city may be ſet on fire by one ſpark: 'now, if the body of fire be different from 'the thing fired, there can be no more parts 'of fire in the whole town on fire, than that 'one ſpark. We ſee bodies of divers kinds 'may be ſet on fire by the light of the ſun, as 'well by the refraction as the reflection, that 'is made in burning-glaſſes. And yet I do 'not believe, that there is any man thinks, that 'particles of fire darted from the ſun can paſs 'through the ſubſtance of a cryſtal globe. 'And in the air, between the ſun and the globe 'there is no fire.' But I doubt his adverſaries will ſay, that he is ſo far from having in this paſſage well confuted their opinions, that he ſeems not to have well underſtood them: for they will tell him, that they teach not, that the fire is materially different from every part of the fewel; but that the igneous corpuſcles, whilſt they are divided, blended and oppreſt with the others, have not the power to ſhine or burn, till being by ſome ſpark or other body actually burning, or by ſome other equivalent cauſe extricated, they flock together in ſwarms, and then are able to burn and ſhine, that is, to appear fire: which fire is yet but a part of the fewel; as appears by the phlegm, aſhes, and perhaps other incombuſtible parts of the coal or other fewel. So that the Atomiſts and divers others will not allow, what Mr. *Hobbes* infers about an *incendium*. And whereas he tells us he believes, that no body thinks *particulas igneas à ſole ejectas tranſire poſſe per ſubſtantiam globuli cryſtallini*; he ſeems to me to have very little heeded the Epicurean hypotheſis. For, not only the learned *Gaſſendus*, but I know not how many other Atomiſts (beſides other Naturaliſts) antient and modern, expreſly teach the ſun-beams to conſiſt of fiery corpuſcles, trajected through the air, and capable of paſſing through glaſs; whereby theſe authors give an account of thoſe *ſpecula uſtoria*, that burn by reflexion. Theſe things I repreſent, not that I intend here to adopt the Atomiſts opinion of the nature of fire, of which I am not obliged to declare my thoughts here, and have done it elſewhere; but to ſhew, that Mr. *Hobbes*'s arguments are not a ſufficient ground for ſo heavy a cenſure. And if a coal be kindled at one end, though Mr. *Hobbes* would have the kindled end a coal, not fire; yet if he pleaſe to hold it in his naked hand, he may find that differs enough from the other end to deſerve another name. And I, that but related a phænomenon, did not perhaps expreſs myſelf much leſs warily, if not more ſo, than Mr. *Hobbes* himſelf. For whereas my words are theſe, *We preſently took out the coals, in which it ſeems there had remained ſome little parcels of fire, rather covered than totally quenched; for in the open air the coals began to be re-kindled in ſeveral places*: Mr. *Hobbes* even in his elements of philoſophy ſpeaks thus upon a ſomewhat-like occaſion; *If a grate filled with coals thoroughly kindled, and burning never ſo brightly, be let down, as ſoon as ever it is below C. the fire will begin to grow pale, and ſhortly after (loſing its light) be extinguiſhed, no otherwiſe than if it were quenched in water: but if the grate be drawn up again preſently, while the coals are ſtill very hot, the fire will by little and little be kindled again, and ſhine as before.*

As for the reaſon Mr. *Hobbes* aſſigns of our experiment in the lately mentioned paſſage of his dialogue, being grounded upon ſuch a thickneſs of the air in the receiver as we have already diſproved, it needs not to be examined. And laſtly, as to what he ſubjoins in theſe words, *Quando autem eſt, quod de homine vere pronunciare*

Pag. 18. Pag. 18. Pag. 32. Chap. 30. ſect. 14. Pag. 18. Pag. 18.

pronunciare poſſumus quod eſt mortuus, ſive (quod idem eſt) animam expiravit. Cognitum enim eſt homines nonnullos pro mortuis habitos poſtridie elatos revixiſſe.

A. *De puncto temporis, quo anima à corpore ſeparatur, difficile eſt ſtatuere. Perge igitur ad experimenta alia.*'

'When is it, that we may truly ſay of a 'man that he is dead, or (which is the ſame) 'hath expired his ſoul? For it has been known, 'that ſome men, who have been taken for dead, 'being brought out the next day, revived?

A. 'It is hard to determine the point of 'time, in which the ſoul is ſeparated from the 'body. Proceed therefore to other experi-'ments.'

I confeſs I ſee not why that needleſs queſtion might not have been well ſpared, if he deſigned to give it no better anſwer.

CHAP. VI.

Wherein other paſſages of Mr. Hobbes's *Dialogue, that concern the author, are examined.*

WHAT our author has in the 19th page concerning a bladder, has been already examined: wherefore I proceed to the next paſſage in the ſame page, which is this:

B. Si acus magnete excitus libere pendeat intra recipiens, ſequetur tamen ille motum ferri quod circumducitur extra recipiens. Item objecta intus poſita ab iis qui extra ſunt videbuntur, & ſoni intus facti audientur, omnia hæc æque poſt atque ante exuctionem aëris, niſi quod ſoni ſunt aliquanto poſt quàm ante debiliores.

A. Manifeſtiſſima hæc ſunt ſigna recipientis ſemper pleni, nec poſſe inde exugi aërem. Quod autem ſoni inde ſentiantur debiliores, ſignum eſt conſiſtentiæ aëris. Conſiſtentia autem aëris à motu ejus eſt per lineas diametraliter oppoſitas.

'*B.* If a needle excited by a loadſtone hang 'freely within the receiver, it will nevertheleſs 'follow the motion of the iron, which is drawn 'about without the receiver. So objects put 'within will be ſeen by thoſe that are without, 'and ſounds made within will be heard without: 'all theſe as well after as before the exſuction of 'the air, except that the ſounds are ſomewhat 'more weakly heard after than before.

A. 'Theſe are moſt manifeſt ſigns, that the 'receiver is always full, and that the air cannot 'thence be ſucked out. That the ſounds 'thence are more weak to one's hearing is a 'ſign of the conſiſtence of the air; for the 'conſiſtence of the air is diametrically oppoſite 'from its motion.' But I meet with few of the Vacuiſts, who, even in the Torricellian experiment, think the place relinquiſhed by the quickſilver to be perfectly void, moſt of them allowing, that though it be not quite full of body, yet it may contain ſome of the earth's magnetical ſteams, or of thoſe igneous corpuſcles that flow from the ſun, or both of them. Now againſt theſe, who would from our experiments deduce but only an interſperſed vacuum, I ſee not, that the phænomena mentioned by Mr. *Hobbes* do conclude half ſo manifeſtly as he pretends: for, as to the motion of the needle within the receiver, it is known, that they are wont to aſcribe magnetical attraction to certain effluvia, that iſſuing out of the loadſtone are ſubtile enough to paſs through the pores of the cloſeſt bodies without excepting glaſs; ſo that although the receiver were quite emptied before, the needle might be wrought upon by magnetical corpuſcles, that need not be ſuppoſed to fill the tenth part of the receiver. I know indeed, that Mr. *Hobbes* has another hypotheſis of the phænomena of the loadſtone; but I know, that divers learned writers have abſolutely rejected it, and not one ſuch, that I have heard of, has approved it. And as for the other two phænomena here mentioned by Mr. *Hobbes*, the Atomiſts may anſwer, that the firſt (touching objects ſeen in the receiver) has been ſhewn already not to overthrow their doctrine; and that the other (concerning the debilitation of ſounds) makes againſt him, not for him; ſince we have already diſproved, that conſiſtence of the air, whereto he aſcribes it. And the ſame arguments, that overthrow that opinion, may make it ſeem ſomewhat ſtrange, that he ſhould ſubjoin our experiment of two like pendula, whoſe vibrations we found not manifeſtly to differ within and without our exhauſted receiver. For the former ſhould move far ſlower than the other, according to Mr. *Hobbes*'s conceit, that the receiver, when we ſay it is exhauſted, is filled with a ſubſtance of a middle conſiſtence betwixt pure air and water, and not much lighter than water *. But whether the receiver be in ſuch caſes adequately full or no, the Vacuiſts may further conſider. For its being granted to be full would not overthrow either of my hypotheſes, namely, the weight and ſpring of the air.

IN the ſame 19th, and ſome following pages, Mr. *Hobbes* has a long diſcourſe againſt my conjecture at the reaſon I propoſe in my 31ſt experiment, why (as I here expreſs it) if the exquiſitely poliſhed ſurfaces of two flat pieces of marble be ſo congruous to each other, that upon their mutual application there *reſults* an immediate contact, they will ſtick ſo faſt together, that he, that lifts up the uppermoſt, ſhall, if the undermoſt be not exceeding heavy, lift up that too, and ſuſtain it aloft in the free air. The conjecture itſelf is in the ſame page thus *Page 6.* ſet down; 'That the lower ſuperficies of that '(undermoſt) ſtone being freely expoſed to 'the air, is preſſed upon by it; whereas the 'uppermoſt ſurface being contiguous to the 'ſuperior ſtone, is thereby defended from the 'preſſure of the air, which conſequently preſ-'ſing the lower ſtone againſt the upper, hin-'ders it from falling, as we have elſewhere 'more fully declared.' Which laſt words I therefore omit not, becauſe they ſhew, that I handle this matter in this place but incidentally, and may make uſe of what I have delivered, where I treat of it more expreſly; as I have ſince done in print in the *Hiſtory of Fluidity and Firmneſs*, which Mr. *Hobbes* appears to have ſeen by thoſe cenſures of ſome paſſages of it, that I ſhall hereafter examine.

HIS whole diſcourſe concerning my conjecture,

* Compare that in the 30. Chap. 14. Sect. of his Phyſicks, with that of his Dialogue, page 15, 16.

ture, and his ſcheme, would be too prolix to be entirely inſerted. But the thing his diſcourſe drives at is to ſhew, that neither the ſpring nor weight of the air have any thing to do with this phænomenon: and therefore when he had made his academian relate, that two coherent marbles ſuſpended in our receiver did not fall aſunder upon the exhauſtion of it, he ſubjoins that it was, *quia nihil iſtic erat, quod* Page 10. *ageret atmoſphæræ pondus*; and annexes, *Experimento hoc excogitari contra opinionem eorum, qui vacuum aſſerunt, aliud argumentum fortius aut evidentius non potuit. Namſi duorum cohærentium alterutrum ſecundum eam viam in qua jacent ipſæ contiguæ ſuperficies propulſum eſſet, facile ſepararentur, aëre proximo in locum relictum ſucceſſivè ſemper influente; ſed illa ita divellere, ut ſimul totum amitterent contactum, impoſſibile eſt, mundo pleno. Oporteret enim, aut motum fieri ab uno termino ad alium in inſtante, aut duo corpora eodem tempore in eodem eſſe loco: quorum utrumvis dicere eſt abſurdum.* 'Becauſe there 'was nothing there, that the weight of the at-'moſphere ſhould do; no more ſtrong or 'evident argument could be made againſt a 'vacuum than this experiment. For if of two 'coherent marbles either of them ſhould be 'thruſt forward that way, that their ſurfaces lie 'contiguous, they would eaſily be ſever'd; 'the neighbouring air ſucceſſively flowing into 'the deſerted place. But ſo to pull them aſun-'der, that at one time they ſhould loſe their 'whole contact, is impoſſible, the world being 'full. For then either motion muſt be made 'from one term to another in an inſtant, or 'two bodies at the ſame time muſt be in the 'ſame place: to ſay either of which, is abſurd.' But how this ſhould be ſo cogent and manifeſt an argument againſt the Vacuiſts, I confeſs I do not well diſcern. For that, which it proves (if it prove any thing) ſeems to be, that in caſe the cohering marbles could be ſo ſever'd, as to loſe at once their whole contact, the world might be concluded not to be full: but I ſee not how it thence follows, that therefore there can be no vacuum. For my part, I would demand, whether the ſo ſtrong coheſion of the marbles be neceſſary or not to the plenitude of the world. If it be, how chance a ſufficient weight hung to the lower marble can immediately draw them aſunder? And if it be not, why does not Mr. *Hobbes* aſſign ſome other cauſe of their ſo ſtrong adheſion, if it depend neither upon the ſpring nor weight of the air? As for the non-ſeparation of the two marbles in our receiver, I have ſaid, in the ſame 31ſt experiment, that the cauſe may probably be the preſſure of the air remaining in the receiver not ſufficiently exhauſted. And this conjecture I have more fully defended in what I have written about it againſt *Franciſcus Linus*; where I ſhew, that it is no way unlikely, the remaining air ſhould be able to ſuſtain a weight of four or five ounces hanging at the lower marble, ſince the free air was able to ſupport between 400 and 500 ounces hanging at the ſame.

But Mr. *Hobbes* tells us, that the cauſe I aſſign of the coheſion of our marbles is liable to huge inconveniences; of the greatneſs of which we may judge by the firſt of them; *Confitentur* (ſays he) *tum ipſi tum alii omnes,* Page 20. *ponderationem omnem conatum eſſe per lineas rectas undiquaque ad centrum terræ; & proinde non cylindrum vel columnam fieri, ſed per pyramidem, cujus vertex eſt centrum terræ, baſis pars ſuperficiei atmoſphæræ.* 'They themſelves and all others confeſs, that all ponde-'ration is an endeavour every way by right 'lines unto the centre of the earth; and ſo 'that it is made not by the figure of a cylin-'der or column, but by a pyramid, whoſe 'top is the centre of the earth, and whoſe 'baſis is part of the ſurface of the atmoſphere.' As if it were much material, whether a body, whoſe baſis is ſcarce two inches diameter, and whoſe length amounts to ſome thouſands of miles, be conſidered as a cylinder or a pyramid. Certainly *Stevinus*, and other learned writers of the hydroſtaticks, would ſcarce have made his an objection, ſince they ſcruple not to make it a poſtulatum, that all not very diſtant perpendiculars be looked upon as parallel, though they allow ſuch perpendiculars would meet in the centre of the earth. What he adds, partly in theſe words, *Conatus ergo punctorum* Page 20. *omnium ponderantium propagabitur ad ſuperficiem marmoris ſuperioris, antequam poſſit propagari ulterius (puta) ad terram*; 'Therefore the 'endeavour of all the points, that ponderate, 'will be propagated to the ſurface of the upper 'marble, before it can be propagated further '(ſuppoſe) to the earth;' and partly, in the following lines, to prove, that the whole endeavour of the pyramid, that leans upon the upper marble, is terminated there, and that there is no endeavour of the atmoſphere againſt the under-ſuperficies of the lowermoſt marble: this ratiocination ſeems grounded, partly upon a conceit of his about the nature of gravity, according to which I ſee not, why any body placed between the ſides of that pyramid, or rather cone, whereof the upper-ſuperficies of the higher marble is the baſis, ſhould deſcend upon the account of gravity; and partly from a miſtake of my opinion. For I do nowhere, that I know of, ſpeak, as if I thought this ſuſtentation of the lower marble were performed by little globules, or other minute bodies, protruding one another directly towards the centre of the earth, and rebounding from a perfectly ſmooth ſuperficies: nor need I ſay, that the lower ſtone is ſuſtained by the preſſure of the ſelf-ſame pillar of the atmoſphere, that is incumbent on the upper, ſince other parts of the atmoſphere, ſome on the one hand, and ſome on the other, preſſing obliquely upon the uneven ſurface of the earth, may have their preſſure upward terminated againſt the lower ſurface of the undermoſt marble. And in the mentioned *hiſtory of fluidity and firmneſs*, ſpeaking (*page* 187.) of the adheſion of flat glaſſes, (and the reaſon is the ſame in our flat marbles) I plainly deduce it from the preſſure of the fluid air, which, like a liquor, diffuſing itſelf upon the ſurface of the terreſtrial globe, becauſe its deſcent is there reſiſted, does, like water and other liquors, preſs almoſt equally every way, and ſtrongly endeavour to thruſt

away

away any body againſt which it can bear; ſo that where-ever the preſſure is taken off from one part of a body, and not from the oppoſite, that body will be preſt toward that part, whether it be downwards, or ſidewards, or upwards, where that formerly equal reſiſtance is removed. And this explication I do in that diſcourſe back with conſiderations and experiments, which Mr. *Hobbes* is not pleaſed to take any notice of: wherefore I hold it not amiſs to add here two or three other experiments to one of thoſe mentioned there.

FIRST then, an æolipile being by heat freed from air as much as you can, if the little hole at the extremity of the neck, by which the air gets in and out, be preſently and carefully ſtopt with wax, and afterwards ſuffered to cool, there will not be in the cavity of the æolipile a reſiſtance any thing near equal to the preſſure of the outward air. And therefore if you perforate the wax, that air will violently be impelled in at the unſtopt orifice, whether the neck be held parallel or perpendicular to the horizon, or in any other ſituation in reſpect of the centre of the earth. And the like will happen, if the æolipile be unſtopt under water.

NEXT, I relate in the mentioned hiſtory, that having drawn ſome of the air out of a large glaſs with a narrow mouth, and thereby deſtroyed the equality of force betwixt the weight of the outward air, and the now weakned ſpring of the inward; I found, that by immediately applying a flat body to the orifice of the veſſel, that body was readily lifted up and ſuſtained in the air as long as I pleaſed, though the weight of it exceeded twenty ounces.

THIRDLY, I lately met with the relation of an experiment, which does abundantly make out the power of the ambient atmoſphere to preſs bodies againſt each other, when it cannot get between their internal ſurfaces. For the ingenious author of the Magdeburgick experiment writes to the induſtrious *Schottus*, that having cauſed two copper plates to be made almoſt in the form of ſcales a little above half an ell in diameter, and exactly congruous, if laid upon one another; *Has* (ſays our Jeſuit) *ſi mutuo ſibi imponit, & aërem extrahit, adeo ab externi aëris gravitate compreſſæ atque unitæ tenentur, ut ſex viri robuſti eas divellere non poſſint. Quod ſi tandem adhibito omni conatu divellantur, crepitum edunt ſclopeti aut muſquetæ exploſioni non minorem; quamprimum vero per claviculum ſeu epiſtomium apertum vel minimus aditus laxatur aëri, ſponte ſeparantur.* 'Theſe 'ſcales he puts one upon another, and draws 'out the air, and then are they kept ſo com-'preſt and united by the gravity of the exter-'nal air, that ſix ſtrong men cannot pull them 'aſunder. But if at length, by the uſe of 'the utmoſt endeavour, they are pluckt in 'ſunder, they make a noiſe equal to the re-'port of a muſquet; but as ſoon as ever, by 'the ſtop-cock opened, there is the leaſt en-'trance given to the air, they are ſever'd of 'their own accord.'

Schot. Mech. Hyd. Pneumat. page 401.

AND, fourthly, if a glaſs phial (ſuch as will be anon more fully deſcribed) have a pipe open at both ends ſo fitted into it, that no air can get in and out betwixt the neck and it; and if the phial be ſo far filled with water, that the lower end of the pipe be well immerſed therein; if then you ſuck at the upper end of the pipe, the water will aſcend to a good height; which argues its being forced upwards by the oblique preſſure of the air in the phial: for it is only in the pipe, and not in the phial, that there is any air in the ſame perpendicular with the water that is impelled up.

BUT let us follow Mr. *Hobbes* a little further. Having aſked this queſtion, *Sed vis illa elaſtica, quam in aëre eſſe dicunt, nihilne ad marmor ſuſtinendum conferre poteſt?* he anſwers, *Nihil omnino; non enim conatus in aëre eſt ullus ad centrum terræ magis quam ad aliud quodvis punctum univerſi. Quoniam enim gravia omnia tendunt à circumferentia atmoſphæræ ad centrum terræ, & inde rurſus ad circumferentiam atmoſphæræ per eaſdem lineas reflexas, conatus ſurſum conatui deorſum æqualis erit, & proinde mutuo ſe perimentes neutrâ conabuntur viâ.* 'But can 'the ſpring, which they ſay is in the air, 'confer nothing to the holding up the 'marble? —— nothing at all: for there is no 'endeavour of the air to the centre of the 'earth, more than to any other point in the 'univerſe. For ſeeing that heavy things tend 'from the circumference of the atmoſphere 'unto the centre of the earth, and thence a-'gain to the circumference of the atmoſphere 'by the ſame reflected lines, the endeavour 'upwards will be equal to the endeavour 'downwards, and ſo deſtroying one another, 'they will endeavour neither way.' But that the ſpring of the air may perform ſomewhat in the caſe propoſed, I hope the newly mentioned experiments have evinced. And the reaſon he annexes to his negative, as alſo the difficult example he ſubjoins, of a man lying in the bottom of the ſea, ſeem rather oppoſed to the weight than the ſpring of the air. But we have already, both by experiments, and by his own conceſſions, ſufficiently proved, that the air is not devoid of gravity: and that it likewiſe gravitates upon the terraqueous globe, which in this page he ſeems to deny, we have proved by divers reaſons, and particularly in our 25th experiment, by the vaſt expanſion of air under water, when the preſſure of the incumbent air was taken off from the water.

Page 20, 21.

AS for the ſcheme he annexes, I confeſs I do not well ſee what he drives at in it; at leaſt if it be intended for a confutation of the conjecture I have been defending: nor am I the only perſon, that complain of his writing often enough obſcurely. And as far as we can judge by the concluſion, couched in theſe words, *Non poteſt ergo pars* BC (which in the explication of the ſcheme he calls *pars atmoſphæræ intra totam poſita ubicunque*) *(propter magnitudinem) quantumvis gravis ſit, deſcendere, neque ergo premere ſive gravitare*; 'Therefore 'the part BC (that is, a part of the atmoſphere 'placed any where within the whole) cannot '(by reaſon of its greatneſs) deſcend, although 'it be heavy, and therefore it cannot preſs 'or gravitate:' his notions about gravity are

ſomewhat ſtrange, and probably either do not concern us, or will be found repugnant to thoſe experiments, on which our conjecture is grounded.

Pag. 22. AND as for what he adds, *Si poſſibile eſſe negarem, ut diligentiâ & arte humanâ duæ ſuperficies corporum duorum inter ſe per omnia puncta ita accurate congruæ fiant, ut ne minimo quidem corpuſculo creabili tranſitus permittatur, non video quomodo illi aut ſuam hypotheſim tueri, aut negationem noſtram improbitatis arguere jure poſſent:* 'If I ſhould deny it poſſible, that 'by the art of man, two ſurfaces of two 'bodies could be made ſo accurately fit, that 'they ſhould touch in all points, ſo that there 'could no creable corpuſcle paſs between 'them; I do not ſee, how they could defend 'their own hypotheſis, or diſprove our nega-'tive aſſertion:' I confeſs I do not ſee how this argumentation proves any thing againſt the intereſt, either of the weight, or ſo much as of the ſpring of the air in the coheſion of our marbles. For, provided that the corpuſcles of the air get not in between the two ſtones, the preſſure of the air may well ſuffice to keep them together. And, laſtly, as for that modeſt paſſage (that immediately precedes the

Page 21, 22. words newly recited) wherein he ſays, *Utraque illa phantaſia, tum gravitatis atmoſphæræ, tum vis elaſticæ ſive antitupiæ aëris, ſomnium erat. Siquidem autem illis concederetur eſſe aliquam in filiculis aëris antitupiam, quæretque aliquis, unde illa curvata quidem ſed quieſcentia moverentur rurſus ad rectitudinem, deberent illi, ſi phyſici haberi volunt, cauſam ejus aliquam poſſibilem aſſignare:* 'Both theſe fancies, as well that of 'the weight, as of the ſpring or antitupy of 'the air, are dreams. But if it be granted, 'that there is a kind of recoiling in thoſe ſmall 'hairs or ſlender corpuſcles, of which the air 'conſiſts; one may inquire, whence it is, that 'thoſe crooked bodies, ſettled and at quiet in 'that poſture, came to be moved into a 'ſtreightneſs. They ought, if they will be 'eſteemed natural philoſophers, to aſſign ſome 'poſſible cauſe of this:' we have already given an account, why we forbore to aſſign a cauſe of the motion of reſtitution; but methinks Mr. *Hobbes* might have, for the ſpeaking ſo, choſen a fitter place than this, where he gives me ſo fair an opportunity to tell him again, that he ſhould, if he would be thought a Naturaliſt, have aſſigned ſome cauſe of the phænomenon, about which he had all this while been diſputing; which ſince even he himſelf has declined to do, perhaps the phænomenon will be thought ſomewhat difficult, and my attempt at diſcovering the cauſe of it will be at leaſt excuſed.

BUT after having ſo long dwelt upon the conſideration of our marbles, it is high time to proceed to what remains.

IN the 24th page, Mr. *Hobbes* has that paſſage I formerly recited touching the glaſs-fountains, out of which water is thrown up by compreſſed air. But though I, as well as others, have made uſe of ſuch fountains, invented by *Vincenzo Vincenti* of *Urbin*, and was unſatisfied with the account he gives of their phænomena; yet in regard ſome learned men, and particularly Dr. *Ward*, have already examined his explication, and I am not obliged to do ſo; I ſhall only take notice of what our author objects, to prove that this phænomenon cannot be ſolved by the ſpring of the air, in theſe words:

B. *Cur non poteſt aqua, quæ cum injiceretur,* *Page* 22. *particulas aëris comprimebat, ab iiſdem particulis ſe explicantibus rurſus rejici?*

A. *Quia locum explicatæ majorem non requirunt quam compreſſæ. Quemadmodum in vaſe aqua pleno, in qua eſſet multitudo anguillarum, anguillas ſive in ſe volutas ſive explicatas idem ſemper capit locus. Propellere ergo aquam per vim elaſticam, quæ alia non eſt quam motus corporum ſe explicantium, non poſſunt.*

B. *Comparatio illa aëris cum aqua anguillis plena, noſtris, credo, non diſplicebit.*

'*B.* Why cannot the water, which when 'it was injected did compreſs the particles of 'air, be again caſt out by the ſame partices 'explicating themſelves?

'*A.* Becauſe when explicated they require 'no greater place than when compreſſed: as 'in a veſſel full of water, wherein are many 'eels, the ſame proportion of place receives 'them, whether they are folded round or at 'length. Therefore they cannot drive up the 'water by their ſpring, which is nothing elſe 'but the motion of bodies explicating them-'ſelves.

'*B.* The compariſon of air to eels in water, 'I ſuppoſe, will be well received by our acade-'mians.'

BUT the Elateriſts will anſwer, that neither can his earthy atoms, to whom he aſcribes the rejection of the water forced in, truly fill up more parts of ſpace at one time than at another; and therefore the objection might have been ſpared: but indeed it reaches us not. For we, as Mr. *Hobbes* knows well, are not wont to compare the air to eels, but to wooll: and though each hair, that makes up a compreſſed lock of wooll, does not really fill more ſpace with wooll when extended than when crumpled; yet when there is a congeries of theſe hairs compreſſed together, the whole fleece or congeries does by its ſpring endeavour to thruſt away thoſe contiguous bodies, by which it is penned up, as I have more fully explained in my epiſtle: ſo that theſe aërial corpuſcles, being pent up by the water forced into the glaſs, ſtill endeavour to expand themſelves by throwing it out.

WHAT our author adds in the ſame page, as if they were miſtaken, that think the experiments of the Pleniſts tended (eſpecially till of late) to prove, that the generality of them did not always mean by a vacuum a ſpace perfectly devoid of all corporeal ſubſtance, but any ſpace here below, that is not filled with a viſible body, or at leaſt with air, (for theſe are my words, to which I ſuppoſe Mr. *Hobbes* alludes:) to this, I ſay, it is ſcarce worth while to make anſwer, the controverſy being of ſuch ſmall moment, (though I think I could eaſily enough do it) eſpecially ſince he rather excuſes thoſe, that may have negligently expreſſed themſelves, than diſproves what I ſaid. And ſince

I ſpoke chiefly and by name of the Peripatetick ſchools, he may well allow, that their expreſſions concerning this matter were not always ſo accurate, whilſt in this very paſſage he con-

Page 25. cludes with theſe words; *Vides quam ineptum ſit ad explicationem effectuum talium advocare verba metaphorica, ut fugam vacui, horrorem naturæ, &c. quibus olim ad exiſtimationem ſuam tuendam uſæ ſunt ſcholæ:* 'You ſee, how fooliſh 'a thing it is to bring for the explication of ſuch 'effects metaphorical words, as the ſhunning of 'a vacuum, the abhorrence of nature, &c. 'which heretofore the ſchools uſed, to defend 'their reputation.' Nor is what he adds concerning the vacuum to be attributed to *Democritus* and *Epicurus* either clear enough, or of concernment enough to our diſpute, to be inſiſted on by us; eſpecially ſince I ſee not to what purpoſe he brings it in.

BUT there are in this page two particulars, which, though they make little or nothing againſt what I ſaid of the Pleniſts, may deſerve to be taken notice of.

THE ſecond (for I think it expedient to diſpatch that firſt) is couched in theſe words;

Page 25. *In hydriis perforatis ideo hæret aqua, quia quæ per tantillum foramen exiturit, adeo exigua eſt, ut non poſſet ita in longitudinem ſe diffundere, ut deſcendendo aditum aëri faciat per foraminum circumferentias; neque aër ab exeunte aqua pulſus locum alium (in mundo pleno) habere poteſt præterquam quem aqua deſeret:* 'In the gardener's 'watering-pots therefore is the water ſuſpend-'ed, becauſe that which iſſues out at ſo ſmall 'a hole is ſo little, that it cannot diffuſe it ſelf 'to ſuch a length, that by its deſcent it may 'give paſſage to the air through the cir-'cumferences of the holes. Nor can the air 'driven off by the water going out find any 'other place, beſides that which the water 'leaves.'

BUT this experiment I have already examined as it is propoſed in his *Elements of Philoſophy*; and therefore I ſhall now only ſay to the light variation I find of it here, that the reaſon here aſſigned, why the water in gardeners pots cloſed at the top does not deſcend, is not rightly aſſigned, ſince (to omit other objections) by Monſieur *Paſchal*'s experiment it appears, that though in pipes of no great length the water will not run out, yet if the pipe be long enough, though the orifice be no wider, the water will deſcend without giving paſſage to the air at the circumference of it.

BUT the other particular here mentioned by Mr. *Hobbes*, who thus propoſes it, *Qui per*

Page 25. *fiſtulam ore aquam ſugit, aërem medium prius ſugit, quo diſtentum aërem externum removet; qui remotus locum (in pleno) habere niſi proximum removendo non poteſt; & ſic continua pulſione aqua tandem pellitur in fiſtulam, ſucceditque aëri, qui exugitur:* 'He that ſucks water into 'his mouth by a pipe, firſt ſucks up the air 'between, whereby he removes the diſtended 'external air, which being removed (the world 'being full) it can have no place but by re-'moving the next, and ſo by continual pulſions 'the water is at length driven into the pipe, 'and doth ſucceed the air, which is ſucked out;' deſerves a more particular conſideration. For this account of the aſcenſion of liquors by ſuction is not only here given by Mr. *Hobbes*, but for the main by the learned *Gaſſendus* himſelf, and other Atomiſts, and is generally acquieſced in by the modern philoſophers; perhaps the rather, becauſe it ſeems not to eſtabliſh or overthrow a vacuum. But though I ſhall not deny, but that many phænomena of nature may be probably explicated by this propagation and return of motion; yet there are ſome phænomena here below, which I ſee not how the Carteſians, or the Atomiſts, or Mr. *Hobbes* can explicate, without admitting the ſpring of the air, and which perhaps by the ſpring of the air may be explicated, without the recurring to ſuch a propagation and return of impulſe. Divers inſtances to this purpoſe I elſewhere conſider, but at preſent I ſhall propoſe only one experiment purpoſely deviſed to ſhew, that both Vacuiſts and Pleniſts ſhould admit an elaſtical power in the air. I took then a glaſs-veſſel conſiſting of two parts; the one was a phial capable of containing about a pound of water, and the other a pipe open at both ends, the lower of which reached within two inches of the bottom of the phial. This pipe was by the glaſs-man faſtened into the neck of the phial, not by any cement, leſt it ſhould be pretended, that the air might undiſcernedly get in or out, but with melted glaſs of a good thickneſs: into this veſſel, by the open pipe, I at length (for it is ſomewhat difficult) poured water enough to ſwim a pretty way above the lower extreme of the pipe, and then often inclined the veſſel, to give a free intercourſe betwixt the air within the phial and that without it, that if the internal air were compreſſed by the affuſion of the water, it might free it ſelf, as it readily did by aſcending in bubbles along the inclined pipe, till the outward and inward air were reduced to an equality of preſſure. Now if all ſuction were produced by the preſſure of the air, thruſt away by the dilated cheſt of him that ſucks, and ſo thruſting the water or other liquor into the pipe at which he ſucks, it ſeems evident, in our caſe, that the water would not aſcend by ſuction; ſince by the contrivance of the veſſel, the air thruſt away by him, that ſucks, cannot at all come to bear or preſs upon the water. And yet, whether the pipe were inclined or erected, the water did according to my expectation eaſily enough aſcend, upon ſuction, to the top of the pipe, and ran over into my mouth. I ſay, eaſily enough; becauſe that though the ſpring of the air pent up in the phial were able, upon the decreaſe of the preſſure of the outward air, occaſioned by my ſucking, to impel the water ſtrongly enough into the pipe; yet, when a pretty quantity of water had been ſo impelled up, the included air gaining thereby more room to expand itſelf, its ſpring was thereby ſo far weakened, that the water aſcended far leſs eaſily than in ordinary ſuction. The other circumſtances worth noting in this experiment belong not to this place; and what has been delivered may, I hope, ſuffice for the purpoſe it is alledged for. Only one particular I ſhall here add, by way of confirmation

firmation of what I ſaid touching the weakened ſpring of the air, and it is this; that partly to ſhew ſome, who yet embrace the opinion of the ſchools, that the aſcenſion of the water in the pipe did not proceed from any ſuch tendency in the water it ſelf to aſcend for prevention of a vacuum, and partly for other reaſons, that concern not this place, I did carefully take out the water by degrees, till the lower end of the pipe was but very little under the ſurface of the water; though in the cavity of the pipe, the water, as it uſually will be in pipes that are not wide, was a pretty deal higher. Then ſuffering the veſſel to reſt, and ſucking at the upper end of the pipe, the water (as I foreſaw it would be) was impelled up, yet without reaching near the top, till the ſurface of it was fallen a little below the bottom of the pipe. But then, though I continued ſucking, no more water aſcended into the pipe, but the air paſſing through it towards my mouth, did in its paſſage toſs up the water, that was already in the pipe, and turn it into bubbles, (of a ſtrong bigneſs, when the cavity of the pipe would permit it) which broke (not without noiſe) one after another: and thus the aſcending air for a pretty while kept the water in the pipe from falling back to that in the phial. But when I removed my mouth, the ſpring of the air remaining in the cavity of the phial, being debilitated by the receſs of the air I had (as men are wont to ſpeak) ſucked out, it was not able to reſiſt the preſſure of the outward air, and accordingly the water in the pipe was not only depreſſed into the phial, but the outward air forced its way in many bubbles, and not without ſome noiſe, through the water contiguous to the bottom of the pipe, till the preſſure of the included air and that of the atmoſphere were reduced to an equality.

But in the ſame 25th page our author tells us, that the ſociety he writes againſt, would have the cauſe of filtration, and that of the paſſage of water through ſiphons, to be the ſame. To which he annexes, this peremptory paſſage; *Id vero impoſſibile eſt. Nam in ſiphone niſi ambo crura aquâ impleantur, aqua è pelvi non aſcendet. Aſcenſionis cauſa in pannum eſt motus ille terrearum atomorum, quæ aquæ contiguæ ſunt, motus (inquam) circularis ſimplex aëri in quo moventur communicatus; quæ atomi aquam ferientes in materiam laneam incutiunt, incuſſæ autem magis magiſque madefaciunt, donec madida tota ſit. Cum vero madida tota ſit, &c.*
'But that is impoſſible: for in a ſiphon, unleſs both legs are filled with water, the water will not aſcend out of the baſon. The cauſe of its aſcent into that cloth is the motion of the earthy atoms, which are near the water; I ſay the ſimple circular motion communicated to the air, in which they move; which atoms ſtriking the water, beat it up into the woolly matter, which beating of them againſt the cloth, makes it more and more moiſt, till it becomes all over wet. And when it is ſo, *&c.*' Thus far he; but the paſſage in my epiſtle, upon which he ſeems to have grounded his oppoſition, is but this, (wherewith I begin my 35th experiment:) *Some learned mathematicians* (I meant the induſtrious *Schottus* and ſome Carteſians) *have of late ingeniouſly endeavoured to reduce filtres to ſiphons; but ſtill the cauſe of the aſcenſion of water and other liquor, both in ſiphons and filtration, needing (for aught we have yet found) a clearer diſcovery and explication, we were deſirous to try*, &c. So that neither did I aſcribe this reduction (of filtres to ſiphons) to a ſociety, which was not then in being, nor perhaps ſo much as deſigned; nor did I adopt it myſelf; but expreſſed a deſire to have it further examined. But as for the cauſe of filtration itſelf, I may take a fitter opportunity to diſcourſe of it: in the mean time, I doubt, whether the reaſon here aſſigned by Mr. *Hobbes* will not ſeem as well precarious, as the *motus circularis ſimplex* of earthy atoms, whereon it is grounded. Nor does his explication render a reaſon, why quickſilver will not aſcend the 14th part as high in the filtre, though in part immerſed into it, as water; nay, will not reach ſo high, where it is contiguous to the filtre, as where it is not: nor why it ſhould begin to aſcend, ſince, for aught he ſhews to the contrary, the preſſure of the air, even in the ſenſe he takes the air, ought to be the ſame on that part of the ſurface of the liquor, which is contiguous to the filtre, and on any other part of the ſame ſurface. To which I ſhall only add, that as reſolutely as Mr. *Hobbes* ſays it is impoſſible for the water to aſcend out of the veſſel into a ſiphon, unleſs both the legs be filled with that liquor, he would probably have ſpoken more warily, and diſtinguiſhed betwixt ſiphons, if he had been pleaſed to take notice of what I relate in the forementioned 35th experiment, of a ſmall glaſs-ſiphon I deviſed, whereof when the ſhorter leg was but dipped in water, the liquor did preſently, as it were of itſelf, run down the longer leg. Which experiment, beſides other conſiderations, may induce us to ſuſpect, that the nature of ſiphons, and of filtration, may not yet be ſo throughly underſtood, as not to deſerve a further inquiry.

But to draw at length towards a concluſion of our troubleſome *Examen*; it remains only, that I take ſome notice of the general corollary, that Mr. *Hobbes* is pleaſed to deduce from his whole diſcourſe, of the experiments exhibited in our engine.

A. *Fateris ergo* (ſays he) *nihil hactenus à collegis tuis promotam eſſe ſcientiam cauſarum naturalium, niſi quod unus eorum machinam invenerit, qua motus excitari aëris poſſit talis, ut partes ſphæræ ſimul undiquaque tendant ad centrum, & ut hypotheſes* Hobbianæ, *ante quidem ſatis probabiles, hinc reddantur probabiliores.* Page 23.

B. *Nec fateri pudet; nam, Eſt aliquid prodire tenus, ſi non datur ultra.*

A. *Quid tenus? Quorſum autem tantus apparatus & ſumptus machinarum factu difficilium, ut eatenus tantum prodiretis, quantum ante prodierat* Hobbius? *Cur non inde potius incepiſtis, ubi ille deſiit? cur principiis ab eo poſitis non eſtis uſi? Cumque* Ariſtoteles *rectè dixiſſet, Ignorato motu ignorari naturam, quomodo tantum in vos ſuſcipere-onus auſi eſtis, &c.*

'A. You

'*A.* You confeſs then, that your collegiates 'have as yet in nothing advanced the know-'ledge of natural cauſes, but that one of them 'hath found out an engine, in which there may 'be ſuch a motion of the air excited, that the 'parts of the ſphere may together every way 'tend unto the centre; and that the hypo-'theſes of Mr. *Hobbes*, before probable enough, 'may be thence made more probable.

'*B.* Right; I am not aſhamed to confeſs it; 'for it is ſomewhat to arrive ſo far, if we can 'make no further progreſs.

'*A.* Why *ſo far*? To what end ſuch prepara-'tion and charge for engines difficult to be 'made, to make no further diſcovery than Mr. '*Hobbes* had made before you? Why did you 'not rather begin where he ended? Why did 'you not uſe the principles he had laid; and 'when *Ariſtotle* had rightly ſaid, that *without* '*the knowledge of motion there is no knowledge* '*of nature*; how durſt you take ſuch a task 'upon your ſelves?'

As to what he ſays to the diſparagement of the aſſembly, and in his own praiſe, the laws I preſcribed myſelf, at the beginning of this diſcourſe, forbid me to reply to what is more likely, amongſt civil and judicious readers, to prejudice his own reputation, than theirs he is ſo diſpleaſed with. And as for that, which he aſſigns to be the uſe of our engine, I ſhall very willingly leave it to the ingenious to judge, what uſe may be made of it. But as for this mentioned by Mr. *Hobbes*, if he means here, as he elſewhere teaches (pag. 13, and 19) that the motion he ſpeaks of is produced by that of the air impelled betwixt the ſides of the ſucker and the cylinder; perhaps it will be thought I have ſufficiently proved, that it is not *any* of its uſes, ſo far is it from being its chief or only uſe. But I confeſs I ſomewhat wonder Mr. *Hobbes* ſhould quarrel with me, (for it is I that in my epiſtle employ the following verſe) for ſaying,

Eſt aliquid prodire tenus, ſi non datur ultra.
'Thus to have made an entrance, though
'we miſs
'Of further progreſs, ſome performance is.

And this not, as ſome would perhaps ſuſpect, becauſe I do not imitate him, in ſpeaking of myſelf, as he does of himſelf, but becauſe he thinks the expreſſion too arrogant. For ſince he here confeſſes, that his hypotheſes are by this engine rendred more probable, ſome will perchance think that to be enough to entitle my experiment to ſome degree of uſefulneſs, unleſs Mr. *Hobbes*'s doctrine of the air had found more embracers than before theſe ſeaſonable, though deſpiſed experiments, it was obſerved to have. But, ſince either of us may be partial in his own caſe, I am very well content to leave others to judge, both whether my expreſſion have been guilty of arrogance, and how much he has done more than *prodire* [illegible] in all the paſt long diſcourſe againſt me, which they have conſidered, what new experi[illegible] matter of fact Mr. *Hobbes* has therein added to enrich the hiſtory of nature, what new truths he has diſcovered, or what errors (except one of his own in the laſt page) he has well confuted. Theſe things, I ſay, I am very well content to leave to be judged of by all diſintereſted perſons, without being much diſcouraged by the differing ſtrain, wherein Mr. *Hobbes* thinks fit to ſpeak of his own performances and mine, or invited to imitate him in that way of writing; my endeavours (ſuch as they are) having hitherto been favoured with ſuch a reception among the Virtuoſi, that poſſibly I may have almoſt as little need as reaſon to commend them.

BUT it is ſomewhat troubleſome work to argue long with a man, that's angry with an expreſſion, which perhaps none but he would have found fault with for want of modeſty: and therefore, as I have left un-recited ſeveral provoking and very undeſerved expreſſions he employs in the ſame page, and even that paſſage, where, to prove our naturaliſts and mathematicians profeſſed they would not receive truth coming from him, he alledges only a ſaying (whether true or no, I examine not) of Dr. *Owen*, who, beſides that his profeſſion was divinity, not philoſophy or mathematics, neither is nor ever was of our ſociety: as, I ſay, I have (for the reaſon newly intimated) declined taking notice of matters of this nature; ſo I will not now ſtay to inquire, why he urges us, whom he would have men take for Vacuiſts, with the authority of *Ariſtotle*, whom, on other occaſions, he is wont to uſe with as little reſpect, as if he were a member of our ſociety. Nor ſhall I now examine, why here, and elſewhere, he ſends us to his own writings for the doctrine of motion; as if, to omit antienter authors, ſuch great perſonages as *Galilæo*, *Merſennus*, *Verulam*, *Des Cartes*, *Gaſſendus*, *Balianus*, *Johannes Marcus Marci*, *Honoratus Fabri*, (not to mention other moderns, nor thoſe of our own aſſembly, as the eminently-learned Sir *Kenelme Digby*, and the others, whom their modeſty forbids me here to name) had not moſt of them learnedly, and ſome of them copiouſly, written of local motion before Mr. *Hobbes*'s books, where he treats of it, came abroad into the world: this, I ſay, I ſhall not inſiſt on, becauſe I would haſten to a concluſion. Only one thing I muſt add, that whereas he accuſes us of deviſing elaborate and ſumptuous engines, I do not fear to find ſo many readers of his mind, that I need make them excuſes for what perhaps will obtain their thanks. And whatever Mr. *Hobbes* may think, for my part I freely confeſs, that I love truth ſo well, that I do not think, not only my pains and charges, but, even what I rate much higher, my time it ſelf, too much for the diſcovery of truth; or (that Mr. *Hobbes* may not think me partial) even for the eſtabliſhment of ſuch truths, as, though diſcovered by ſome, are yet as far more generally oppoſed than embraced.

THERE remain yet ſome other pages of Mr. *Hobbes*'s dialogue, wherein he ſpeaks of fire, and cold, and ice, and light, and colours, and fluidity, and hardneſs, and thickneſs, and ethics, and politics, and the duplication of

the cube, and the quadrature of the circle, and ſeveral other ſubjects. But theſe I forbear to meddle with, not that I approve them all, or the greateſt part, but partly, becauſe I am too much tired already, to be fond of engaging in controverſies, that I am not tied to meddle with, (except what concerns fluidity and firmneſs, which I ſhall, God willing, examine by it ſelf;) partly, becauſe divers paſſages relate to perſons, not things: partly becauſe I do not much fear, that Mr. *Hobbes* will find every reader ſo eaſy and complaiſant as he makes his academian, who in many paſſages of the dialogue ſpeaks not unſuitably to what he does in the laſt page of it; where he excepts but one particular, (and that is neither the *duplication of the cube, nor the ſquaring of the circle,*) when he tells Mr. *Hobbes, diſcedo jam multo (ut mihi videor) quam ante certior, & quæ dixiſti omnia teneo & probo:* and partly, becauſe Mr. *Hobbes* has ſome things, as about fire, and certain colours, which I am not forward to reject, though the conſiderations, that incline me to ſome ſuch opinions, be perhaps very differing from the grounds, on which he propoſes them. And indeed as well my nature as my cuſtom forbids me to ſcruple to learn, if I can, of perſons much leſs famous than Mr. *Hobbes*. It is far from my humour to write againſt all that every-man ſays, that (how cauſeleſly ſoever) writes againſt me; and I am almoſt as much indiſpoſed to reject as to embrace, without diſtinction, whatever it be, that this or that man teaches.

CHAP. VII.

(Being an Appendix to the paſt Diſcourſe:) Wherein is examined what Mr. Hobbes *teaches concerning Fluidity and Firmneſs.*

ALTHOUGH Mr. *Hobbes* do not name me for the maintainer of the opinions which I have propoſed in the *Hiſtory of Fluidity and Firmneſs*, and which he cenſures; yet, ſince that hiſtory, after having been mentioned in the book I have hitherto been defending, was publiſhed a good while before Mr. *Hobbes*'s dialogue; and ſince ſome of the chief particulars he cenſures or takes notice of, are delivered there, and ſome of them, perchance, no where elſe; I think it may concern me to examine what he ſays either againſt my opinions, or in favour of his own, touching *Fluidity and Firmneſs*. And if it be ſaid, that he meant not his objections particularly againſt me, but rather againſt ſome other perſon, who may have liked ſuch opinions; I ſhall anſwer, that I am content to leave to others the defence of their particular opinions, and to have as much of the following diſcourſe, as is concerned in this allegation, looked upon as written only upon this ſuppoſition, that my writings are thoſe he deſigns to oppoſe. But there being other things in what he diſcourſes about *Fluidity and Firmneſs*, which, for the reaſons freſhly intimated, I think fit here to conſider, I chuſe to gather up together the paſſages touching theſe ſubjects, which I find ſcattered in his dialogue, that I may have the better opportunity to clear up the matter itſelf under debate.

BUT, before I go further, I muſt, at the very entrance of this diſcourſe, take notice, that in the fifth page, where Mr. *Hobbes* begins to diſpute againſt our notion of *Fluidity*, he very much miſtakes my opinion, as may appear by theſe words, which he puts into the mouth of his academian; *Sed pleriq́ue noſtrum naturam* Page 5. *fluidam à non fluida diſtinguimus magnitudine partium, ex quibus corpus aliquod conſtat, & quaſi compingitur: itaque non modo aërem, aquam & liquorem omnem, ſed etiam cinerem & pulverem, tanquam fluida contemplamur. Et fluida ex non fluidis compoſita eſſe poſſe non negamus; nam diviſibilitatem illam infinitam non concoquimus.* To which he anſwers, *Diviſio quidem infinita concipi non poteſt, diviſibilitas autem facile. Ego contra, diſtinctionem non capio intra fluida & non fluida, quam ſumitis à magnitudine partium; nam ſi caperem, ruina illa ſive rudera illa, quæ jacent in eccleſia Paulina, mihi dicenda eſſent fluida: ſin propter nimiam lapidum magnitudinem fluida illa eſſe negaveritis, deſini mihi magnitudinem illam, quam habens pars ruentis muri propter eam ſit dicenda fluida. Tu vero, qui diviſibilitatem infinitam non capis, dic mihi, quæ tibi apparet cauſa, quare Deo omnipotenti difficilius eſſe putem creare corpus fluidum, & cujus partes actu diffluant, omni data atomo minus, quam creare oceanum. Itaque deſperare me facis omnem conventus veſtri fructum, dicendo, quod putant aërem, aquam, & cætera fluida conſtare ex non fluidis, tanquam ſi murum, cujus ruentes lapides aliquouſque diſcurrunt, dicerent eſſe fluidum. Si ſic loquendum eſt, nihil non eſt fluidum; nam etiam marmor comminui poteſt in partes omni atomo Epicureana minores.*' ' But moſt of us ' diſtinguiſh the nature of fluid from that ' which is not fluid, by the greatneſs of the ' parts, of which any body conſiſts and is made ' up with. Wherefore we do not only look ' upon air, water, and all liquors, but upon ' aſhes alſo and duſt, as fluid bodies. And ' we deny not, that fluid things may be made ' of things not fluid; for we do not digeſt the ' notion of infinite diviſibility.

A. ' Infinite diviſion cannot be conceived, ' but (infinite) diviſibility may eaſily. I, on the ' contrary, do not underſtand the diſtinction of ' fluids and not fluids, which you take from ' the greatneſs of the parts: could I digeſt ' this, I muſt ſay, the ruins of ſhattered rubbiſh ſtones, that lie in *Paul*'s, were fluid. But ' if thoſe ruins cannot be called fluid, becauſe ' the ſtones are too big, define me the bigneſs, ' that the parts of a ruined wall muſt have, ' that they may be called fluid. But you, that ' cannot underſtand infinite diviſibility, tell ' me what you think to be the cauſe, why I ' ſhould think it more hard for almighty God ' to create a fluid body leſs than any atom propoſed, that its parts might actually flow, ' than to create the ocean? Therefore you ' make me deſpair of any fruit of your meeting, ' by ſaying, that they think air, water, and ' other fluids conſiſt of non-fluids; as if a wall, ' that began to fall and be ruinous, were called ' by them a fluid body. If they may ſpeak ' ſo, every thing is fluid, for even marble ' itſelf may be broken into parts leſs than any ' atom imagined by *Epicurus*.' Thus he.

But in my Hiſtory, though I make the ſmallneſs of the parts, whereof a body conſiſts, one of the requiſites to its being fluid; yet at the end of the 13th ſection I call the various agitation of thoſe particles the principal qualification of all, and in the beginning of the 14th ſection I call it the chief condition of a fluid body. And therefore he much miſtakes, if he thinks, that we always conſider aſhes and duſt as fluids abſolutely ſpeaking. But as he * ſomewhere tells us, that by fire he underſtands the combuſtible matter itſelf, not ſimply and always, but then only when, *&c.* ſo neither do I look upon the duſt of alabaſter (to my words about which, I ſuppoſe, he has a reſpect in the paſſage under conſideration) as a fluid body ſimply and always; for I clearly teach the contrary, but only when and whilſt its parts are not alone reduced to a competent ſmallneſs, but are alſo actually put into ſuch a various agitation as makes the body they compoſe (even according to Mr. *Hobbes*'s own definition, which is, that 'fluid bodies are thoſe whoſe parts may, by 'very weak endeavour, be ſeparated from one 'another') emulate a fluid body, by the very eaſy ceſſion of its component corpuſcles, and by its boiling like a liquor. By this the reader may diſcern how little, that makes againſt me, which Mr. *Hobbes* talks, and ſeems to do it ſeriouſly, of the ruins of *Paul*'s; as if, according to my opinion, *Ruina illa ſive rudera, quæ jacent in eccleſia Paulina, dicenda eſſent fluida*; 'the ruins that lie in *Paul*'s church might be 'called fluid.' For it is moſt evident, that I require in the parts of a fluid body both minuteneſs and ſuch a motion along each other, as makes them eaſily yield to the touch: which qualifications, how well they belong to the ruins of *Paul*'s, is, I think, not very difficult to determine; though in the ſame paſſage Mr. *Hobbes* does again make uſe of the like example, to which he ſubjoins, *Si ſic loquendum eſt, nihil non eſt fluidum*; 'if they may ſo ſpeak, there 'is nothing but is fluid.' Which, how little it follows from my doctrine about *Fluidity*, there needs not a quick-ſighted reader to diſcern. As for the reaſon he annexes in theſe words, *Nam etiam marmor comminui poteſt in partes omni atomo Epicureana minores*; 'for even 'marble may be beaten into parts leſs than 'any Epicurean atom:' I would gladly know, by what art Mr. *Hobbes* can divide marble into leſſer particles than ſuch as are naturally indiviſible, (for ſuch *Epicurus* makes his atoms to be:) nor do I ſee how, in caſe this could be done, it proves, that there is not any thing, that is not fluid. For I ſay, that the blocks of marble before comminution are not fluid, either according to him or according to me; nay, the greateſt comminution imaginable would not, according to my doctrine, make a lump of marble fluid, unleſs the heap compoſed of the parts, how minute ſoever, were actually and variouſly ſet a moving amongſt themſelves. But he would perhaps have ſpoken more warily, if he had conſidered the difference there is betwixt ſaying, that all things are fluid, and ſaying, as I do, that there are many bodies, that are now ſolid, which by comminution, motion, and other requiſite alterations, may be made parts of a fluid body: as hard ice may be turned into fluid water, and quickſilver precipitated *per ſe* into a red powder, may be reduced to running mercury. As for what he ſays of an infinite diviſibility of body, it is ſcarce in this place worth while to examine it.

* *Hobbes de Corp. ch.* 27.

Mr. *Hobbes de Corpore, cap.* 26. *part.* 4.

FOR I have ſhewn in the *Hiſtory of Firmneſs*, that this diviſibility (which I had then conſidered) does no way overthrow my doctrine of fluidity; nor does Mr. *Hobbes* here anſwer what I there diſcourſe. Beſides that indeed, I do not ſo well underſtand what he means and drives at, when he ſays that *Diviſio quidem infinita concipi non poteſt, diviſibilitas autem facile:* 'Di-'viſion that is infinite cannot be conceived, 'diviſibility may eaſily.' For ſince in this very paſſage and within a very few lines he has recourſe in this matter to God's omnipotence, I ſee not, why an infinite diviſion cannot be as well conceived as an infinite diviſibility, ſince ſure an omnipotent agent is able to do what is poſſible to be done; and why elſe ſhould a body be called infinitely diviſible? Beſides, when Mr. *Hobbes* has recourſe to what God can do, (whoſe omnipotence we have both great reaſon to acknowledge) it imports not to the controverſy about fluidity to determine what the almighty Creator can do, but what he actually has done. And laſtly, whereas my adverſary requires to have the magnitude defined, which a part of a falling wall ought to have to deſerve the name of fluid; firſt, he ſhould have clearly proved, that fluidity belongs to any one ſingle part of matter, how minute ſoever, and not rather to an aggregate of particles. And next I ſay thoſe corpuſcles, that compoſe a fluid body may be of ſeveral ſizes, as thoſe of water, oil, and quickſilver, provided they be little enough to be put into the agitation, requiſite to give the aggregate they make up the qualities, that are wont to denominate bodies fluid; and it is no more requiſite for me to define preciſely the magnitudes of the parts of a fluid body, than for Mr. *Hobbes* in his definition above-recited to define (which he will not eaſily do) what preciſe degree of endeavour muſt be ſignified by that very weak endeavour, by which if the parts of a body can be ſeparated from one another, he thinks fit to call them fluid. But though I thought it not amiſs to make theſe animadverſions upon Mr. *Hobbes*'s ratiocination, yet as to the opinion it ſelf, for whoſe ſake he ſpeaks ſo ſeverely and ſo deſpairingly of our ſociety, if it be conſidered as I propoſed it, he ſhews me as yet no cauſe at all to renounce it. For that which I taught is this, that if a ſolid body be reduced into parts minute enough, thoſe ſolid corpuſcles, whilſt they are put into a convenient motion, may become parts of a fluid body. And againſt this Mr. *Hobbes*'s indignation ſeems ſtronger than his argument: for that which he objects being, as we have lately ſeen, that at this rate all bodies muſt be fluid; it is evident by what I have already argued, that he infers this abſurdity not from my opinion, but his own miſtake of it: nor did I content my ſelf with the proof-leſs propoſal of my conjecture, but I delivered, in ſeveral parts

of

of the often mentioned hiſtory, particular experiments to evince what I taught; as that a conſiſtent coagulum of pure ſpirits of urine and wine may, by bare digeſtion, be turned into a permanent liquor; and that the fluid body of quickſilver may, without any ſenſible addition, be turned into a permanent dry powder, and may again in a trice by bare heat be turned into a laſting fluid body. Whereto I added other experiments, which together with theſe Mr. *Hobbes* would poſſibly have thought fit to anſwer, if he had found it eaſy for him to do ſo.

AFTER this paſſage extant in Mr. *Hobbes*'s fifth page, that I have all this while been examining, I remember nothing in his dialogue, that requires to be inſiſted on about fluidity and firmneſs, till we come to the 29th page; where, having aſked what cauſe the academians aſſign of hardneſs, it is anſwered, that ſome of them aſſign three: to which Mr. *Hobbes* ſo far
Pag. 29. agrees as to ſay, *Quin corpuſcula (qualia ſunt atomi, quas ſupponit* Lucretius *atque etiam* Hobbius) *jam ante dura facile poſſint ab aliqua dictarum cauſarum compingi, ita ut totum ex illis factum durum fiat, dubitandum non eſt:* 'But 'the corpuſcles (ſuch as are the atoms ſuppoſed 'by *Lucretius* and alſo by Mr. *Hobbes*) being 'hard before, might be eaſily compacted by any 'of the mentioned cauſes; ſo that it is not to 'be doubted, but that the whole to be made of 'thoſe corpuſcles will be hard.' But then he would have us aſſign the cauſe of that he calls *durum primum*. But after ſome diſcourſe, wherein he is pleaſed to approve an objection of mine againſt ſome learned men, that aſcribe all coheſion of bodies to a certain glue, he anſwers himſelf the objection he frames againſt my doctrine about hardneſs, and thereby allowed me to proceed to what he further preſſes
Page 30. in theſe words; *Si dura ex primis duris fieri dicant, quare non & fluida fieri putant ex primis fluidis? An creari fluida maxima potuere, ut æther, minima non potuere? Qui corpuſculum durum aut fluidum primus fecit, potuit, ſi libuiſſet, illud feciſſe tum majus, tum minus quocunque corpore dato. Quod ſi fluidum fiat ex non fluidis, ut vos dicitis, & durum ex duris tantum, nonne ſequitur ex fluidis primis, neque fluidum fieri neque durum?* 'If hard bodies are made out of 'parts originally hard, why are not fluid bo- 'dies made of parts originally fluid? Could 'great fluids, as the æther, be created; and 'could not ſmall ones? He that firſt made a 'body hard or fluid, could, if he would, have 'made it greater or leſs than any other pro- 'poſed body. Now if a fluid body be made 'of parts not fluid, (as you ſpeak) and hard 'bodies only from hard parts; doth it not 'follow, that nothing neither fluid nor hard is 'made of original fluids?' But againſt this paſſage I have divers things to repreſent. For, firſt, (not now to mention, that it may be queſtioned with what propriety one part of matter more than another may be called *primum durum*) he ſhould have told us what he means by his *prima fluida*, and how he proves that there are any ſuch; which ſince he has not done, it will be at leaſt as hard for a conſidering man to acquieſce in his queſtion as to anſwer it. For my part, I know no fluid body upon whoſe account, as of an ingredient, all others are fluid. And I think, it will be hard for Mr. *Hobbes* to ſhew, that water, quickſilver, and purely-rectified chymical oils (to name now no other liquors) do conſiſt of ſuch *fluida prima* as he teaches, whereto they owe all their fluidity. And it is plain by ſeveral experiments delivered in our hiſtory, and even by the obvious changes of water and ice into one another, that it is the motion, reſt, and the texture of the corpuſcles, which compoſe a body, that make it firm or fluid. As for what Mr. *Hobbes* demands, whether the ſmalleſt fluids imaginable could not as well have been created as the æther, it proves nothing againſt me, the queſtion not being, what might have been made, but what is ſo. And he ſhould have anſwered the arguments I * alledge to make it improbable that, a fluid body is, as he would perſuade us in his book † *De Corpore*, always diviſible into bodies equally fluid, as quantity into quantities. It is true, he there tells us that, though many others do not, 'he underſtands by fluidity, that 'which is made ſuch by nature equally in every 'part of the fluid body, in ſuch manner, as 'water ſeems fluid, and to divide itſelf into 'parts perpetually fluid.' But whether others will take this for a clear notion of fluidity, I think may well be doubted; and he ſhould not barely ſay, but prove, (which I think he will find hard to do) that the corpuſcles of water divide themſelves ſo as he teaches, ſince we ſee, that not only they cannot penetrate glaſs, but are unable to be driven in at the pores of more open bodies, which other liquors eaſily pierce into. And, laſtly, as to Mr. *Hobbes*'s queſtion, *Quod ſi fluidum fiat, &c.* it is eaſy to foreſee, what, according to my doctrine, I may anſwer: for, not to mention that the argumentation is invalid, unleſs by *fluidum* he mean *omne fluidum*, I reply, that till he have explained what he means by his *fluida prima*, and proved that there are ſuch, the queſtion needs no anſwer. Beſides that, whatever he, upon miſtakes, ſtrives to infer, my doctrine is ſo far from affirming, that there are many parts, of matter, of which neither fluid nor hard bodies can be made; that I teach, as we have lately ſeen, that there are multitudes of parts, that may, by being reduced to a ſufficient ſmalneſs, and put into a convenient motion, or by being brought to a mutual contact and reſt, be made to conſtitue either a fluid body or a firm one: as may be exemplified in the formerly-mentioned inſtances of two ſubtile liquors, that immediately compoſed a conſiſtent body; and of quickſilver, which without additaments was made ſometimes a powder, and ſometimes a liquor. What Mr. *Hobbes* adds in the next *Page* 31.
page about the difficulty of explaining the diaphaneity of glaſs or cryſtal, in caſe they conſiſted of corpuſcles hard and implicated, or having their pores in any way whatſoever diſjoined, I muſt not now inſiſt on; ſince beſides that

* Hiſtory of Firmneſs, page 227, and elſewhere.

† Chap. 16. ſect. 4.

that ſuch a diſquiſition would require almoſt a volume, the true and general cauſe of tranſparency in bodies is, in my poor opinion, one of the abſtruſeſt things in natural philoſophy; and Mr. *Hobbes*'s explication of it (though none of his worſt conceits) has, for aught I can find, fallen ſhort of ſatisfying the curious, as well as thoſe of other men have done. But to me, that have not taken upon me to write elements of philoſophy, it is enough, that I have, by competent experiments, and other proofs, confirmed the truth of my doctrine about the cauſe of firmneſs; though I attempt not to explicate the other qualities of the ſame bodies, whoſe explication my undertaking does not exact. Wherefore I hope I may now haſten to conclude this Appendix, with ſpending a few words on the notion of fluidity and firmneſs Mr. *Hobbes* would ſubſtitute inſtead of mine. For, having now (perhaps but too prolixly) examined what he has been pleaſed to object againſt my doctrine, I ſhall not need ſpend time to vindicate the experiments and conſiderations whereon I built it; Mr. *Hobbes*, for reaſons beſt known to himſelf, not having thought fit to take notice of them.

MR. *Hobbes*'s theory of fluidity and firmneſs is thus delivered by himſelf;

Page 30. B. *Quænam duri & fluidi ſunt principia?*

A. *Quid aliud niſi fluidi quidem quies, duri autem motus quidam ad illum effectum producendum idoneus? Per quietem intelligo duarum partium inter ſe quietem, cum ſe mutuo tangunt quidem, ſed non premunt: nam & fluida moveri tota poſſunt retenta fluiditate, & dura quieſcere, ut tamen partes eorum moveantur.*

'*B.* What are the principles of fluidity and firmneſs?

'*A.* Of fluidity, nothing but reſt; of firmneſs, motion; ſuch as is fit to produce that effect. By reſt I underſtand the reſt of two parts one with another, when they each touch, but neither preſs one another. For entire bodies of fluids may be in motion, their fluidity abiding, and hard bodies be at reſt, although their parts be in motion.'

I DOUBT not, but this will to moſt readers ſeem a paradox. And as for his ratiocination contained in the two laſt lines, I ſhall readily allow him, that *fluida moveri tota poſſunt retenta fluiditate*; ſince that I think agrees at leaſt as well with my hypotheſis as his: but whereas he adds, that hard bodies may reſt, and yet their parts be moved, that may in one caſe be conceived, and in another not. For indeed the implicated parts of a firm body may be made to tremble, or a little vibrate as it were to and fro, as thoſe of a ſounding bell do, or as in a hedge, the branches and twigs may be ſhaken by the wind, whilſt the trees and buſhes themſelves continue rooted in the ground. But that, in a body, the conſtituent corpuſcles ſhould all, or moſt of them, be moved quite out of their places, in reſpect of one another, as was lately ſhewn to happen in fluids, and yet the body continue hard, is more requiſite than eaſy to be proved.

BUT Mr. *Hobbes* contents himſelf to alledge, in favour of his ſtrange notion touching fluidity and firmneſs, three particulars, which, I confeſs, afford me not the leaſt ſatisfaction.

THE firſt is drawn from what he formerly taught touching the ſwift motion of the air in our cylinder; which example (as he calls it) having repeated, he adds, *Atque hinc manifeſtum eſt vehementem eſſe in aëre ita moto & clauſo compreſſionem, quantam ſcilicet efficere poteſt vis illa qua incuſſus erat; atque etiam à tanta compreſſione aliquem gradum conſiſtentiæ fieri, quanquam conſiſtentia aquæ minorem. Quod ſi eſſet in iiſdem particulis aëris omnibus, præter motum illum, quo altera alteram premit, motus ille circularis ſimplex, iſque ſatis vehemens, impoſſibile fere eſſet unam earum à ſuo circello dimoveri, quin, reliquis particulis reſiſtentibus, totus ſimul premeretur, id eſt, totum durum eſſet: durum enim eſt totum illud, cujus nulla cedit pars niſi cedente toto. Vides ergo poſſe fieri duritiem in fluidiſſimo aëre per motum hunc circularem ſimplicem particularem, quibus duo motus contrarii ante dederant vertiginem.* Page 30. '*And* hence it 'is manifeſt, that there is a great compreſſion 'in the air ſo moved and ſhut up; namely, ſo 'great as that force, by which it was driven in 'was able to make; and alſo, that from ſo 'great compreſſion ſome degree of conſiſtence 'muſt be made, though leſs than that of the 'conſiſtence of water. Now, if in all the 'ſame particles of air, beſides the motion, by 'which one preſſes another, there was alſo the 'ſimple circular motion, and that vehement 'enough, it would be almoſt impoſſible any 'one of them ſhould be moved from its little 'circle, but that the other particles reſiſting, 'the whole would be preſſed together, that is, 'become hard; for that is hard of which no 'part gives place but upon the motion of the 'whole. You ſee therefore that hardneſs may 'be made in a moſt fluid body by this ſimple 'circular motion of particles, which was be'fore imparted to them by two contrary mo'tions.'

BUT, I confeſs, I do not ſee, how the *motus circularis ſimplex* he talks of ſhould give ſuch a hardneſs to the fluid air: nor is it manifeſt to me, how the air, that perfectly fills the cylinder, can be by motion compreſt, eſpecially ſo far as to obtain thereby a degree of conſiſtence fit to be mentioned, as he ſpeaks of it, when (without adding the word *much*, or any other equivalent term) he ſays, that yet it is *leſs than the conſiſtence of water*. For the cylinder being, according to him, perfectly full of air, I ſee not how the pumping can make the cavity (to uſe his own expreſſion elſewhere) *fuller than full*; nor conſequently can compreſs air to a conſiſtence any thing near that of water, without penetration of dimenſions. But theſe things were mentioned only *ex abundanti*, for the violent motion itſelf of the air in the cylinder (which motion the argument ſuppoſes) has been already, in the examen of one of the former paſſages of his Dialogue, ſufficiently manifeſted to be contrary to experience.

THE ſecond thing Mr. *Hobbes* alledges is his conceit of the generation of fleſh within the muſcles of the human body. But beſides that,

he takes for granted two or three things, which many learned anatomiſts and phyſicians, even among the moderns, will ſcarce allow him, and which he does not prove: beſides this, I ſay, (which I may elſewhere have occaſion to conſider further) the account he gives of the generation of fleſh from theſe ſuppoſitions, is far from being evidently enough deduced to vie for clearneſs with many of thoſe experiments, which I have alledged in favour of the opinion
Page 31. he oppoſes. And whereas he adds, *Atque talis quidem eſſe poteſt cauſa efficiens duri primi; duri autem ſecundi, id eſt, duri à cohæſione durorum primorum, cauſa poteſt eſſe motus ille idem circularis ſimplex conjunctus cum contactu eorundem ſuperficiali, vel etiam intricatione:* 'And ſuch 'indeed may be the cauſe of the *durum primum*, or firſt hard body. But of the ſecond, 'that is, of the coheſion of the two of theſe 'firſt hard bodies, the cauſe may be the very 'ſame circular motion, conjoined with their 'ſuperficial contact, or perhaps their being one 'with another intricated:' Not again to ſay any thing to his *durum primum*, I confeſs I do not ſee how the *motus circularis ſimplex* ſhould need to be ſuperadded to the contact or intrication of the cohering firm corpuſcles, to procure a coheſion, to which it is needleſs, and which, in divers caſes, may be rather hindered than furthered by it.

THE third thing, that Mr. *Hobbes* alledges, is not ſo much a confirmation of his own doctrine, as an objection, as he ſeems to think,
Page 31. againſt that of his adverſaries. For, *Si ſupponamus* (ſays he preſently after his laſt-recited words) *cum illis, duritiei cauſam eſſe magnitudinem aut craſſitiem partium, quam rationem reddere poterimus, cur durior vel firmior ſit aqua congelata, quam eſt eadem aqua ante congelationem?* 'If we ſuppoſe with them, that the 'cauſe of hardneſs is the greatneſs or thickneſs 'of the parts, what reaſon can we give, why 'congealed water ſhould be harder or firmer, 'than the ſame water is before ſuch congela-'tion?' But it may eaſily be replied, that we make not the bigneſs or groſſneſs of the parts of a body the only or chief cauſe of its hardneſs, but their reſt by one another, which the parts of frozen water have; whereas thoſe of unfrozen water have it not, but are in a ſtate of fluidity, and conſequently not of firmneſs. Which may be illuſtrated by what I * elſewhere relate of pure oil of aniſeeds, and a ſubſtance I diſtilled out of benzoin, both which bodies were ſometimes fluid and ſometimes conſiſtent, as the greater or leſſer warmth of the air kept their parts in a due motion, or ſuffered them to reſt.

BUT in exchange of theſe few and unconcluding arguments, which are all that Mr. *Hobbes* alledges to countenance his paradox, how many experiments and reaſons might we tranſcribe out of our Hiſtory of Fluidity and Firmneſs, in favour of the contrary truth?

AND as critical as Mr. *Hobbes* appears in laying down the requiſites of a good hypotheſis, I muſt make bold to the two conditions he mentions, (page 11.) *ut ſit conceptibilis (id eſt, non abſurda)* which, whether it be enough, I now diſpute not; *& ut ab ea conceſſa inferri poſſit phænomeni neceſſitas*; 'that it be 'conceivable, that is, not abſurd; and that 'from its being granted, the neceſſity of the 'phænomenon may be inferred;' to add a third, namely, that it be not inconſiſtent with any other truth or phænomenon of nature. Which third condition whether divers of Mr. *Hobbes*'s hypotheſes (which himſelf in this place calls *mirandæ*) do not want, we have in part already conſidered in the treatiſe, to which this is an Appendix; and (as I newly intimated) I might further ſhew, as to his notion of fluidity and firmneſs, if I would here repeat all the experiments mentioned in my hiſtory of them, though they be not all that I have made ready to the ſame purpoſe againſt another opportunity: but partly wearineſs, and partly a natural unwillingneſs to repeat, induces me rather to refer my reader thither. Which when I do, I do not forget, that Mr. *Hobbes* appears offended at me and others for troubling ourſelves to make un-obvious experiments. But that I may not repeat what, in divers treatiſes, I repreſent concerning the uſefulneſs of ſuch experiments, I ſhall now only oppoſe to the authority of Mr. *Hobbes* in this Dialogue, (wherein he has been pleaſed to chuſe thoſe he calls the *Experimentarian Philoſophers* for his adverſaries) the authority and reaſon of the ſame Mr. *Hobbes* in another Dialogue (publiſhed but the year before) where one of his two diſcourſers having ſaid, *Qui corpora corporibus admovendo, nova & mirabilia oſtendunt naturæ opera, mirum in modum incendunt animos hominum amore philoſophiæ, & ad cauſas inveſtigandas non parum inſtigant, eoque nomine laude digni ſunt:* 'They 'who, putting bodies to bodies, ſhew the new 'and admirable works of nature, do wonder-'fully inflame the minds of men with the love 'of philoſophy, and do not a little inſtigate 'them unto the ſearch of cauſes, and on that 'account are worthy of commendation:' The other confirms it, by adding, *Ita eſt; nam hiſtoriam naturalem (ſine qua ſcientia naturalis fruſtrà quæritur) locupletant:* 'True; for they 'enrich natural hiſtory, without which natural 'ſcience is in vain ſought for.' And howſoever, Mr. *Hobbes* needed not have recourſe to ſuch experiments, as he would be thought to diſapprove, (I mean elaborate ones) to diſcern, that his notions do not over-well agree with the phænomena. For, if there be not a various motion in the ſmall parts of water and ſuch liquors, whence is it, that a lump of common ſalt being thrown into a pot of water, is there diſſolved into minute bodies, whereof many are carried to the very top of the water, and are ſo exquiſitely diffuſed and mingled with the liquor, that each leaſt drop of it contains numbers of ſaline corpuſcles? And if motion be the cauſe rather of hardneſs than fluidity, how comes it to paſs, that in froſty weather ice is by heat (which Mr. *Hobbes* will not deny to be motion, or an effect of it) turned

Mr. *Hobbes in examinat. & emendatione, &c. Dialog.* 6.

* In the Hiſtory of Fluidity and Firmneſs.

turned from a hard to a fluid body? and that metals, as gold and ſilver, *&c.* whilſt they are cold, or expoſed but to a moderate heat, are firm and conſiſtent bodies; and by a violent heat, which does manifeſtly give their parts a various and vehement agitation, (as appears by their ſudden diſſipating of ſpittle, greaſe, and far more ſtable bodies, caſt upon them, into ſmoak) are put into a fluidity; which, upon their removal from the fire, they quickly exchange for firmneſs?

BUT ſince the want of more to ſay would not, in haſte, put a period to this diſcourſe, I am content to let my haſte break it off; eſpecially ſince after I have thus examined what Mr. *Hobbes* teaches concerning fluidity and firmneſs, either here, or in that ſection of his Elements, where he pretends to define them, I think I need not fear, that a doctrine, which I have perhaps with ſome care endeavoured to eſtabliſh, for the main, upon experiments, ſhould be overthrown by opinions, whoſe grounds are but ſuch as we have already ſeen; and in pleading for which, the author is pleaſed not only to leave almoſt all my arguments untouch'd, but not ſo much as to offer at explicating, by his principles, any of thoſe numerous and important phænomena of fluidity and firmneſs, delivered in the treatiſe he oppoſes.

AND now leaving Mr. *Hobbes*, to apply myſelf to the reader, I have, to the things hitherto diſcourſed, but this one thing to add concerning them; that as little cauſe as Mr. *Hobbes* has hitherto given me, to diſtruſt what I have written of fluidity and firmneſs; yet I am not now more confident of my conjectures than I was, when, toward the end of the preface to the hiſtory of theſe two qualities, I ſpoke diffidently enough of the theorical part of that treatiſe. And I freely confeſs, that the great difficulty of things, and the little abilities I find myſelf furniſhed with to ſurmount it, do often, in general, beget in me a *great* diſtruſt even of things, whereof my adverſary's objections give me not *any*.

SOME

SOME MOTIVES and INCENTIVES TO THE LOVE of GOD,

Pathetically diſcourſed of, in a LETTER to a FRIEND.

To the COUNTESS of *WARWICK.*

My Dear Siſter,

I EXPECT you ſhould ſomewhat wonder, that after having for above eleven years been careful to keep this following letter from the publick view, and that too notwithſtanding the ſollicitation (not to ſay importunity) of divers illuſtrious perſons, and even your commands to releaſe it from its confinement; I ſhould now at length give way to its paſſing abroad into the world, and its making you a publick and ſolemn addreſs. Wherefore judging myſelf obliged to give you an account of a paper, for which you have been long pleaſed ſo highly and ſo obligingly to concern your ſelf, I muſt, to remove your wonder, inform you, that I am reduced to this publication in my own defence. For, whilſt I was far from dreaming of permitting this epiſtle to paſs out of my cloſet, it happened, that a broken copy of it did (by I know not what misfortune for me) fall into the hands of a neceſſitous perſon, who would needs perſuade himſelf, that by printing it, he might relieve ſome of his preſent wants; and thereupon proffered to ſell the copy for a ſum of money. But my good fortune leading him to a ſtationer, to whom my name was not unknown, he very civilly ſent me forthwith notice of the propoſition that was made him, and after came himſelf to acquaint me, that the copy, about which he had been treated with, being but one of two or three, that were then abroad, ſome or other of them would, queſtionleſs, ſoon find the way to the preſs. This unwelcome accident did little leſs trouble than ſurprize me; for, beſides that it impoſed on me the neceſſity of a publication I had ſo long declined; and beſides that I knew, that * compoſures of a very differing nature being expected from me, the appearing of this, inſtead of them, would make this unwelcome to many, though it had fewer imperfections than it has: beſides theſe things, (I ſay) my ſight was then, and is ſtill, ſo impaired by a diſtemper in my eyes; and the hours I could diſpoſe of were ſo pre-ingaged to philoſophical themes, that I could not promiſe my ſelf ſo much as to read it over before its going to the printer. But conſidering after all this, that the copy I had by me was like to prove more full, and leſs faulty, than any of thoſe, that ſome endeavoured to obtrude upon the world, I thought it leſs inconvenient to venture mine own abroad, than to run the hazard of a ſurreptitious edition of a diſcourſe, that could ſo ill bear the appearing with any other blemiſhes, than thoſe it brought with it into the world from my pen. And therefore having put it into the hands of perſons, whoſe eminent abilities the more knowing part of the nation has long and juſtly admired, and begged their impartial opinion and caſtigations of it, (giving them entire liberty to alter or expunge whatever they diſliked;) and finding (by haſtily turning over the leaves) that their caſtigations were only enough to let me ſee, that they had heedfully read it over; and were accompanied with encouragements, which care was taken to keep me from looking upon as meer compliments: I let it go to the preſs, without ſo much as having once peruſed it, or heard it read over, ſince the ſtationer firſt gave me the advertiſement I told you of. Which I made the leſs ſcruple to do, becauſe a critick, whoſe judgment and piety I much reverence, ſeriouſly endeavoured to perſuade me, that I ought not in conſcience to decline publiſhing what he was pleaſed to think proper to kindle or cheriſh the flames of divine love in the breaſts of the readers. And my haſte it ſelf did afterwards promiſe me theſe advantages, that notwithſtanding my book's not coming forth ſooner, I ſhould not loſe the excuſe of youth I had when it was written; nay, and that the faulty paſſages, which may be met with in it, will perhaps be charged upon thoſe, that ſuffered them to paſs uncorrected, when they had ſo abſolute a power to expunge or reform them. Theſe, and the like motives, having induced me to conſent to the publication of the following letter, I needed not deliberate long, to whom I ſhould addreſs it. For, ſince that accompliſhed *Lindamor*, whom it ſo much concerned, has left the world, there is no perſon in it, to whom this addreſs is any thing near ſo due, as unto you, dear ſiſter. It was at that delicious *Leeze*, where you are now the miſtreſs, that this letter was written; and it was of you that I borrowed theſe hours I ſpent in writing it. It was to you, that I ſhewed

* Some Treatiſes relating to Experimental Philoſophy.

ſhewed it almoſt ſheet by ſheet, before I reſolved to ſend it away. It is you, that can beſt excuſe the imperfections of it, as knowing not only the more obvious, but the more private avocations and other diſadvantages, among which it was penned. It is you, that have ever ſince ſollicited me to divulge it, and have given me the greateſt encouragements to do ſo, not only by thoſe ſollicitations, which implied your own favourable opinion of it, but by procuring me (by concealing or diſguiſing my name) the unſuſpected opinions of divers competent judges. In a word, this addreſs belongs upon ſo many ſcores to you, that I could not make it any where elſe, without manifeſtly wronging you. I know, dear Siſter, that it is not uſual to dedicate books to ſo near a relation; and that it is uſual, in dedicatory epiſtles, both to depreciate what one has written, and to extol the perſon that one writes to, eſpecially if it be one of your ſex and quality. But you know too, that I never ſwore allegiance to cuſtom, and therefore will not, I ſuppoſe, wonder to ſee me as little ſollicitous to conform to it on this occaſion as on others. In an age, when ſo few perſons have merit enough to keep that from being flattery, which ſhould be but praiſe, I am not at all ambitious of caſting my ſelf upon the unhappy neceſſity, of either flattering, or appearing rude; when by better chuſing the objects of my addreſſes, I can, as occaſion requires, give praiſes without untruth, or forbear them without incivility. Nor dare I preſume, that a lye ceaſes to be a fault, by being put into a dedicatory epiſtle; as antiently the hurtful beaſts forgot their pernicious nature, when brought into the ark. Not to mention, that books of devotion have generally the ſtrange and unhappy fate of being leſs welcome to them, that moſt, than to them, that leſs, need them. As for the diſcourſe I preſent you, though my opinion of it may be gueſſed at, by the privacy, to which I have ſo long confined it; yet becauſe, as in phyſick, to have a good opinion of the medicine, and the doctor, ſo in books of devotion, (which are a kind of phyſick for the mind) to have one of the compoſure, or of the writer, both inclines us to look after the preſcriptions, and advantages their operations: for this reaſon I ſhall ſay nothing to diſparage a diſcourſe, which is of a nature to aim more at the being practiſed by the readers, than the being pardoned; and ſhall not at all repine to ſee it find, from the publick, as favourable a reception, as it has hitherto met with in cloſets. And now, dear Siſter, though I know you will not, yet I doubt, my other readers will expect, that this letter ſhould, according to the mode of epiſtles dedicatory, be concluded with commendations of you, and compliments to you; it being almoſt as much out of faſhion in ſuch addreſſes to omit giving praiſes, as it is to believe the praiſes given on ſuch occaſion. But, though I can praiſe you without either diſbelieving my ſelf, or fearing to be diſbelieved by any that knows you; yet, beſides that our relation, and our friendſhip, would make ſuch a way of writing miſbecoming me on all occaſions; I know your piety and your modeſty would peculiarly diſallow it upon this; where the ſubject I am to entertain you with is of ſuch a nature, as would make a flaunting addreſs but a very unſuitable introduction to it. The nature of my theme, as well as the ſtrictneſs of your virtue, and our friendſhip, forbidding me here to celebrate you, otherwiſe than by letting the world ſee, that I dare, even in a dedicatory addreſs, without fear of diſpleaſing you, forbear to celebrate you. And if it be demanded, why then I refrain not likewiſe from writing to you a dedication? I ſhall anſwer, that I am unwilling to loſe this opportunity of making a publick acknowledgment, that as I have the honour to be your brother, and your friend, ſo I have the juſtice to think it very much my happineſs to be ſo: eſpecially, ſince you are pleaſed to aſſure me, that my relation to you has rather been the occaſion than the ground of a friendſhip, that does, whilſt it enjoins me to profeſs my ſelf without compliment, oblige me to be, with all the ſincerity that is poſſible,

My dear Siſter,

Your moſt affectionate Brother, and

Moſt faithful, humble Servant,

ROBERT BOYLE.

Advertiſements to the Reader;

(As they were written ſome years ſince, when ſome intelligent perſons were to have a ſight of the following Diſcourſe.)

TO prevent thoſe ſcruples, which elſe might ariſe in the peruſal of the enſuing diſcourſe, the reader of it is requeſted to take notice.

I. THAT though ignorance hath been of late ſo much in faſhion with too many of our young nobility, that ſome paſſages of the enſuing papers may ſeem unfit to have been written to a young gentleman; yet the perſon they were addreſſed to, being both a traveller, a linguiſt, and a ſcholar, it was not improper to diſcourſe with him at the rate of ſuppoſing him ſo qualified.

II. THAT the enſuing letter was not written ſingle, being but the laſt of divers, wherein love in general was confeſſed, juſtified, and celebrated; wherein the received way of making love was explicated, defended, and oppoſed; wherein

wherein conſtancy and inconſtancy in love were argued for and againſt; wherein Platonick love was explicated, celebrated, and wherein the cure of love was propoſed and proſecuted; wherein (to diſpatch) the controverted points concerning love were diſcourſed of, in a way ſuited to the ſeveral themes, and to the humours and principles of the ſuppoſed writers. But all the former papers, (written in compliment to a fair lady) though very free from the guilt of either licentiouſneſs or prophaneneſs, have been by the author judged too little ſerious, either to appear alone, or to accompany the enſuing diſcourſe, wherein he has expreſſed his own opinions, as in the former he but deduced of thoſe imaginary perſons.

III. THAT the following paper was to have been attended by another, wherein the properties and duties of ſeraphick love were to have been explicated and inſiſted on; but the author, before he had written that other, accidentally meeting with a French book, wherein though what he had already diſcourſed of were not handled, he found, that much of what he had deſigned to ſet down was anticipated, and the moſt pertinent conſiderations his intended themes ſuggeſted, were ſkilfully diſplayed already; he feared it might be injurious to his reader, and himſelf, if he ſhould either turn a tranſcriber of others notions, or decline the beſt thoughts belonging to his theme, that the leſs good ones might paſs without ſuſpicion for his own.

L'Amour Divin, de Mr. du Moulin.

IV. THAT the enſuing trifle having been written in haſte, and by ſnatches, amongſt diſtracting avocations, and far from literary accommodations, is freely ſubmitted to the cenſure of learned and impartial peruſers, eſpecially divines; who are by the author requeſted to believe its miſtaken paſſages, and unwary expreſſions, (if it contain any ſuch) to have been altogether unintentional, and ſuch as they ſhall never find it to be more than one labour to make him diſcern and retract; he being reſolved, by God's aſſiſtance, to continue ſtill obſequious enough to all clearer diſcoveries of truth, to be able to ſay, *Errare poſſum, hæreticus eſſe nolo.* And as he is on his part ſo reſigned, and ſo willing to be rectified, ſo he expects this equity from thoſe, to whoſe judgments he ſubmits, that, conſidering he intended not to write a ſolemn and regular treatiſe, but a private and familiar epiſtle, they will paſs by ſuch unaccurateneſſes, as are wont to be incident to compoſers of this later nature. He preſumed he might ſometimes make bold with the vulgar laws of tenſes, treating of an eternity, that admits them not. He hoped, that the freedom taken in ſome of his expreſſions concerning love, and the wonted objects of it, would be excuſed, by its being exacted by the deſign he had upon *Lindamor*, though he had not (which yet he has) otherwiſe accounted for it*. He intends not to adopt thoſe (too often erroneous) traditions of the vulgar, whence he ſometimes draws compariſons, that he may not deny himſelf the liberty taken by the generality of writers, (without excepting the learneder ſort of them) who ſcruple not in popular compoſures to make ſimilies and alluſions grounded on popular traditions and perſuaſions. As for thoſe common places, which the method of our author's diſcourſe allowed him not to decline, he hopes the reader will diſcern by his way of writing, that he loves to uſe them, not as travellers, but as hunters uſe the highways: for the traveller, when he once gets into the road, makes it his buſineſs to keep in it; whereas the hunter, if he meets one lying in his way, is not fond of ſtaying in it, but nimbly croſſes it, or traverſes ſo much of it, as is requiſite to be paſt through in the purſuit of his game. And laſtly, if in ſome few paſſages of the following letter (eſpecially about the beginning of it) the expreſſions are leſs grave and ſolemn than the deſign; the author hopes, that even they will yet appear tolerably ſerious, for the airieſt parts of a letter, written by one young gentleman to another.

SOME

MOTIVES

TO THE

LOVE of GOD.

My deareſt Lindamor,

I AM very much delighted to learn, both by the voice of fame and the information of much more credible relators, that *Hermione*'s cold uſage has cured you of the fever her ſcorching eyes had given you: and that when once you found your ſelf reſerved to ſhew, what wonder her eyes were able to perform, you ſeaſonably reſolved to become an inſtance of the power, rather of reaſon, than of love; and accordingly, did your ſelf the right to fruſtrate the vain hopes, your inſulting miſtreſs cheriſhed

* In a dedication of all the fore-mentioned letters to my lady *T. J.*

cheriſhed to manifeſt in you, that her charms were capable to make your flame perſevere, when her change had made it as well cauſeleſs as hopeleſs. I could wiſh indeed for your ſake, that you owed your cure more intirely to your reaſon, and leſs to your reſentment; that the extraction of your freedom may no ways blemiſh it. But ſince unallayed ſatisfactions are joys too heavenly, to fall to many men's ſhares on earth, I cannot but conclude, that your recovery, even on theſe terms, deſerves I ſhould congratulate it; for the French ſay truly, that *les plus courtes folies ſont les meilleures.* And liberty being too high a bleſſing to be diveſtible of that nature by circumſtances; I (that ſeldom deplore him, who by loſing his miſtreſs recovers himſelf) think, that *Hermione* has but intentionally, not eventually diſobliged you; and hath made your flames a better return, by reſtoring you your own heart, than ſhe could have done by exchanging hers for it. But that which not leaſt endears to me your recovery, is, that I am aſſured by perſons, from whom I dare credit even ſo welcome news, that my endeavours proved ſo happy as to be conducive to it, and that the conſiderations I ventured to preſent you, did at leaſt ſo far contribute to your freedom, as to give you the deſire and the deſign of regaining it. For, I hope, I need not tell you, that I ſeldom uſe endeavours, whoſe proſperouſneſs is more welcome to me, than thoſe that aſpire to ſerve *Lindamor.* And though I cannot ever pay you any great ſervices, in relation to my vaſtly greater deſires, yet I can ſcarce do you little ones, in relation to the delight reſulting from the having done you any. Nor has the joy, which this ſucceſs of my diſcourſes brings me, been ſparingly increaſed by my having ventured them with much more deſire, than expectation, of their proſpering; and leſs out of any ſtrong hope they would ſucceed, than out of an unwillingneſs to leave the means, I thought leaſt improbable, unеſſayed; being invited to excite you to greater hopes than I durſt allow my ſelf for you, by the example of generals, who, whatſoever diſtruſtful thoughts they harbour in their breaſts, ſuppoſe, that (before the battle) to make their ſoldiers fight ſucceſsfully, it is as well conducive as requiſite, by encouraging orations, to make them think they ſhall do ſo. For, although I endeavoured indeed to perſuade you, that reaſon being born ſovereign of the paſſions; though her lenity or ſupineneſs do ſometimes both occaſion and permit their uſurpations, ſhe is ſeldom ſo diveſted of her native power, but that whenſoever ſhe pleaſeth to imploy what ſhe hath left, ſhe is able to reſume what ſhe hath loſt. And though I was willing you ſhould believe, that to perfect what your reſentment had begun, was a taſk ſo eaſy, that the victory was as much in your power, as the reſolution of attempting it; yet, notwithſtanding all this, I ſay, I was once half perſuaded, that to undertake the curing of a lover was the next weakneſs to the being one. And, *Lindamor,* to deal ingenuouſly with you, your recovery hath circumſtances in it, that make me very apprehenſive, that you are not yet out of the danger of a relapſe, and that you have not half ſo abſolutely abandoned your former amorous conſtitution of mind, as the former idol of it. I know, that from a perſon, who, for one that hath never yet been hurt by *Cupid* is accuſed of uſing him ſlightly and ſeverely enough, you will expect endeavours to preſerve you from relapſes, by ſuch diſſuaſions from love, as its votaries will ſcarce vouchſafe ſo mild a title to, as that of invectives againſt it. And I ſhall ingenuouſly acknowledge, *Lindamor,* that I have been ſometimes no very unready ſatiriſt on that theme; and with a pen, reliſhing of the liberty I cheriſhed in my heart, endeavoured to diſabuſe thoſe ſervile ſouls, that being born to reaſon, ſo far degraded themſelves, as to boaſt ſolely an exceſs of paſſion; and had ſuch low and narrow thoughts of felicity and miſery, as to expect either from a woman's uſage. All which I thought I might the freelier do, becauſe having never known the infelicities of love, but in the ſufferings of others, I might probably ſuppoſe, that my declamations againſt it would paſs for the productions of my reaſon, not my revenge. But, *Lindamor,* though the extravagancies of ſome men's folly have been ſometimes too great, to let me avoid laughing ſomewhat ſatirically at it; yet I am really too little an enemy to love, unleſs exceſſive or miſplaced, by indiſtinct and diſfiguring conſiderations, to repreſent to you the nobleſt paſſion of the mind, as its moſt hideous and formidable diſeaſe.

To love even with ſome paſſionateneſs the perſon you would marry, is not only allowable but expedient, being almoſt neceſſary to the duty of fixing your affection, where you have once engaged your faith; for, it hath been obſerved, that love doth ſeldom ſuffer itſelf to be confined by other matches than thoſe of its own making. And few, but they, that are ſo wiſe as they ſee cauſe to be almoſt in love before-hand with thoſe they marry, prove ſo honeſt, as afterwards to be in love with none elſe. Since therefore the marriage of a wife man ſuppoſes at leaſt as high a degree of love, as he is capable to cheriſh without forfeiting that title; I can ſcarce diſallow the being moderately in love, without being injurious to marriage, which is a relation, that though I can with much leſs reluctancy permit others, than contract my ſelf; yet dare I not abſolutely condemn a condition of life, as expedient to no man, without which, even Paradiſe and innocence were not ſufficient to complete the happineſs of the firſt man. Thus you ſee, *Lindamor,* that I do not promiſcuouſly quarrel with all ſorts of love, but endeavour only to poſſeſs you with this truth, that as antiently among the Jews there were odoriferous unguents, which it was neither unuſual nor unlawful to anoint themſelves with, or beſtow upon their friends; but there was a certain peculiar compoſition too of a precious ointment, which God having reſerved to be employed in his own ſervice, with that the perfuming of their friends was criminal and ſacrilegious: ſo there are regulated degrees of love, which it is not forbidden to harbour for a friend, a miſtreſs, or a wife; *Sect.* 1.

but there is too, a certain peculiar ſtrain, or (if I may ſo call it) heroick temperament of love, which, wherever it is found, makes it belong, as unalienable, as juſtly unto God. A virtuous wife may love both her huſband's relations and her own, and yet be truly ſaid to love him with her whole heart; becauſe there is a certain unrivalled degree of kindneſs, and a peculiar ſort of love, which conſtitutes true conjugal affection, that ſhe confines to him, and reſerves entirely for him, and would think it criminal to harbour for any other perſon: ſo a religious ſoul may obey the command, of loving God entirely, though ſhe allow her affections other objects; provided they be kept in a due ſubordination to, and kept from entering into competition with, that love, which ought to be appropriated to him; and which reſults chiefly from an either altogether, or almoſt unincreaſable elevation, and vaſtneſs of affection; from an entire reſignment to, and an abſolute dependence on, the loved party; from a reſtleſs diſquiet upon the leaſt ſenſe or doubt of her diſpleaſure; from a greater concern in her intereſts, than one's own; from an expectation of no leſs than felicity or wretchedneſs from her friendſhip or indignation; or at leaſt, a perſuadedneſs, that nothing can be a greater happineſs, than her favour, or deſerve the name of happineſs without it. For, wherever a paſſion has theſe properties, or any of them, conſpicuous in it; it cannot, but by being conſecrated to God, avoid becoming injurious both to him and to itſelf. The very nobleneſs of it entitles him to it; as in ſome kingdoms, (and particularly here in *England*) though veins of coarſer metals may belong to the owner of the ſoil they grow in, yet all the mines of the more perfect metals (as gold and ſilver) are by the law made mines royal, and belong to the king, to whom their value appropriates them. By reflecting upon this peculiar notion of love, you may be pleaſed, *Lindamor*, to interpret ſuch indefinite expreſſions as you may meet with in the following diſcourſe. And this love I have taken the freedom to ſtyle *Seraphick Love* (not out of any affectation of tumid words or titles, but) borrowing the name from (if the Romiſh divines be good marſhals of the heavenly hoſt) thoſe nobler ſpirits of the celeſtial hierarchy, whoſe name * in the language to which it belongs, expreſſes them to be of a flaming nature; and whoſe employment (mentioned in the evangelical prophet's myſterious viſion) ſufficiently points at the divine object, to which the flames, that warm them, aſpire and tend. And methinks, *Lindamor*, that you ſhould find it no faint invitation to imbrace ſeraphick love, that you may have the advantage, by making your ſelf a rival to theſe glorious ſpirits, to make them your friends, and the honour to be ingaged in a ſervice, where you are ſure of ſuch illuſtrious concurrents. At leaſt if you be of the mind of that generous youth, (to whoſe ſucceſsful valour the conquered world was both theatre and trophy) who refuſed to run at the Olympick games, becauſe there were no monarchs to run with him. But I fear, *Lindamor*, I have a little digreſſed; ſince I might have told you in fewer words, that it is not my deſign in this paper to declaim againſt love in general, or make a ſolemn harangue of the fickleneſs of women; and that therefore, as when young gallants (ſuch as you, *Lindamor*) are ſubject to caſt away their love upon unfit objects, their diſcreet friends, (ſenſible of the truth of the Italian comick's obſervation, that

Oneſtá contra' amore
E troppo frale ſchermo
In giovinetto cuore;

In youthful hearts bare vertues
wont to prove
But a weak ſhield againſt the
darts of love:)

without taking any more than neceſſary notice of their former fond and ſtraggling paſſions, reclaim them by either matching them, or at leaſt (in order thereunto) engaging their addreſſes to perſons, whoſe beauty or prerogatives may both legitimate or confine their affections: ſo I ſhall now endeavour to prevent the future gaddings of your love to objects, that cannot deſerve ſo tranſcendent and diſintereſted a one, as I have obſerved yours to have been; by preferring and engaging it to the true object, that paſſion was born to, the nobleſt it can aſpire to, and the moſt ſatisfying it can enjoy. Yes, *Lindamor*, as it has hitherto been my not-unproſperous taſk to unhood your ſoul, I ſhall now make it my buſineſs to ſhew her game to fly at. I ſee, that love in *Lindamor* is too noble and predominant an affection, to be either eaſy or fit to be deſtroyed. It will therefore be my deſign, not to ſuppreſs your flame, but to addreſs it. I wiſhed it withdrawn from *Hermione*, not to annihilate it, but to transfigure it. I would not have a paſſion, which wanted nothing, but a due object, to be ſeraphick love, like vulgar men, be ſwallowed up by death, the common fate; but he, ennobled by a deſtiny like that of *Enoch* and *Elias*, who, having ceaſed to converſe with mortals, died not, but were tranſlated into heaven.

Isa. vi. 2, 3.

WHAT has been ſaid already, *Lindamor*, Sect. 2. hath, it ſeems, ſufficed to rectify your love; by diſabuſing it, and ſhewing you, how unfitly it was placed on its former objects. Your proficiency in that invites me to proceed with you to a new leſſon, and (mindful of that true ſaying of an eminent father, *Nemo aliquem amat, quem non vult eſſe meliorem*) to endeavour to exalt your paſſion by directing and ſettling it upon an object, the due contemplation of whoſe lovelineſs may cure as perfectly all hurts received from any mortal beauty, as antiently the ſight of the myſterious ſerpent on the pole did cure the hurts

* The name *Seraphim*, in Hebrew, ſprings from the root *Saraph*, which ſignifies to burn or flame: whence, *Numb* xxi. 6 thoſe pernicious creatures, that our tranſlators engliſh, *fery ſerpents*, are ſtyled in the original *Hanne-chaſim Has-ſeraphim*.

Numb. xxi. 8, 9. hurts the fiery ſerpents gave. For, ſince to gaze ſtedfaſtly on an outward beauty, where all your looking will but diſcover the ſame face, is found ſo effectual to kindle or to blow the fire of love, (which the Greeks prettily enough expreſs by their ἐκ τῦ ὁρᾶν γίνεται τὸ ἐρᾶν) how much muſt a due contemplation enamour us of that divine, and, though refulgent, yet ever more and more diſcoverable object, where attention and wonder ſtill mutually excite and cheriſh each other? whence the zealouſeſt and perfecteſt lovers of God are the glorious angels, Mat. xviii. 20. of whom our Saviour ſays, that in heaven, *they always behold the face of his father which is in heaven*; and thoſe bleſſed ſaints, whoſe imployment, and whoſe happineſs is, in the *Revelation*, Rev. xiv. 4. expreſſed to be, *to follow the lamb whitherſoever he goes*. And thoſe unblemiſhed perſons are in that place recorded to have kept themſelves undefiled by mortal beauties, to teach us, that the nearer and clearer intuition, that heaven affords them of the glorious object of their paſſion, was not the cauſe of it, but the recompence; and that whilſt they lived exiles here on earth, it was ſuch a ſpeculation, as I am recommending (*Lindamor*) to you, wherewith they lived (to borrow the expreſſion Heb. xi. 27. uſed of *Moſes*) *as ſeeing him who is inviſible*; a ſight, whoſe glory made them look on fading beauties with as undazled and untroubled eyes, as eagles can be ſuppoſed to caſt on glow-worms, when they have been newly gazing on the ſun.

Sect. 3. To engage your love, *Lindamor*, to this ſublimeſt of objects, I ſhall deſire, that all that I have ſaid to divert your former flames, and all that may ſay to depreciate and diſcredit thoſe degrading and diſquieting amours, that are wont to inveigle mortals, may be looked upon as meant, rather by way of preparative, than of motive, aiming but to diſabuſe and rectify your mind, that with compoſed and unpreposſeſſed thoughts you may judge of the object I propoſe to you. Which to qualify you to be but impartial to, this method ſeemed expedient; being but imployed upon ſuch a ſcore, as that on which the Platoniſts uſed to premiſe certain virtues, which they (ſignificantly enough) called purgative, to diſpoſe and fit the mind for the reception of ſublimer truths. As phyſicians to clear the ſight are wont to purge the head, that the eye, freed from all darkening and diſguiſing tinctures, may the more perfectly diſcern the objects preſented to it. And certainly, the love I would perſuade, is of a nature, that makes nothing more conducive to it than the greateſt uncloudedneſs of the eye, and the perfecteſt illuſtration of the object; which is ſuch, that the cleareſt reaſon is the moſt advantageous light it can deſire to be ſeen by. You know the ſtory of that witty wench, who uſed merrily to wiſh her lovers all good qualities, but a good underſtanding; for that, ſaid ſhe, would make them out of love with me. The divine object, to which I would prefer you, *Lindamor*, is ſo far from being obnoxious to a danger of that nature, that I need not diſparage any other to enamour you of this. For, the Creator is too full of excellencies to need to be recommended or ſet off by the creature's defects. He was ſovereignly lovely in himſelf, before they had a being; nor has his giving us that paſſion, called love, made him the unfitter object for it. To love God, but becauſe your miſtreſs has perſonal faults, is a greater, than any of thoſe, for which you have declined her; and is ſuch a ſolœciſm in ſeraphick love, as it were in the Perſian religion, (for that has yet embracers in the Eaſt, as thoſe, that have there converſed with them, aſſure me) to make the ſpots, that blemiſh the moon, the motives of their worſhipping the ſun. *Hermione* is a lady, to whoſe noble relations I am too much a ſervant, not to have a reſpect for her; and I cannot without concluding her an extraordinary perſon, remember, how lately ſhe enjoyed the honour of captivating *Lindamor*; and though ſhe has ſince, by injuriouſly declining, juſtly forfeited the glorious title of his miſtreſs; yet the qualities, that gave it her, made me, among divers others, like her ſo well, that it is now my quarrel to her, that ſhe is not what ſhe was. And therefore whatever may fall from my pen to her diſadvantage, relates to her but as ſhe was, or may again be, an obſtacle to your devotedneſs to ſeraphick love. To ingage you to which, (all this notwithſtanding,) *Lindamor*, I muſt do you the right to tell you, that God deſerves the higheſt elevation of your love, though *Hermione* had not rejected it. Were ſhe not only as handſome as you fancied her, but as conſtant as you wiſhed her, her beauty and her friendſhip too concurring could not have made her other than as diſadvantageous as injurious a rival unto God; and, in the very fruition of as obliging returns, as her kindneſs could have made your paſſion, ſhe would have deſerved but a more moderate degree of it. Angels, to whom women were never falſe or cruel, love their Maker above all things: and he to whom St. *John* preſents his adoration, refuſed it for himſelf to direct it unto God. Would not your ſelf, *Lindamor*, have thought your *Hermione* abſolutely handſome, though Moors had not worn the devil's livery; and the thing called deformity had been as much a ſtranger, as it is unwelcome to her ſex? It is true, ſuch is our frailty, that, as the Iſraelites needed a cruel and oppreſſive bondage in *Egypt*, to make them reſolve on returning to the bleſſed land of *Canaan*; ſo oftentimes, the amorous ſoul needs the harſh uſage of a diſdainful miſtreſs, to diſguſt it with its thraldom, and make it aſpire to its more genuine and ſatisfying object. I may therefore allow *Hermione*'s defects to have given you freedom and occaſion to conſider the prerogatives of *Seraphick Love*; but I muſt not allow them to be the chief motives of your embracing it. For, it were too injurious to its glorious object, to make that but the refuge of a defeated paſſion, whoſe tranſcendency entitles it to more than the moſt elevated and entire one. Alas, God needs not theſe beggarly parallels with any fading objects, to become that of our diſabuſed devotion; and he were lovely without compariſon, as well as he is ſo above it. And though I be not ſo unjuſt to deny, Rev. xxii. 4. and xix. 1.

that

that there are ladies (ſome of which I have the happineſs not to be unknown to myſelf) whoſe excellencies are capable of ennobling their whole ſex: yet their greateſt accompliſhments compared to his perfections, whoſe gifts they are, are, in that eclipſing company, as inconſpicuous as the faint qualities of more ordinary perſons. As when in a clear morning, the riſing-ſun vouchſafes to viſit us, as well thoſe bright ſtars that did adorn our hemiſphere, as thoſe dark ſhades that did benight it, vaniſh: conſonantly whereunto, give me leave to obſerve to you, *Lindamor*, that though divers of God's attributes are through his goodneſs participated by his creatures, yet the ſcripture makes ſo vaſt a diſparity betwixt the excellencies, that it aſcribes to men, and the ſame perfections conſidered as they exiſt in God, that it ſeems abſolutely to exclude created beings from any title to thoſe attributes; becauſe they poſſeſs them but in a way ſo inferior to that tranſcendent, peculiar, and divine manner, in which they belong to God. Thus our Saviour ſays to him, that (taking him but for a man) called him good, *Why calleſt thou me good? there is none good but one*, that is, *God*. Thus St. *Paul* calls God (or Chriſt) the only potentate, μόνος δυνάστης, though the earth be ſhared by ſeveral potentates; and even the devout eunuch in the *Acts*, and the depoſed grandees mentioned by the bleſſed virgin in her canticle, are, in the original, ſtyled potentates. Thus, though there be wiſe virgins as well as fooliſh, and though our Saviour tells us, that *the children of this world are in their generations wiſer than the children of light*; yet St. *Paul* ſcruples not to term his Maker, *The only wiſe God*: and thus he elſewhere paraphraſes him, *He that hath only immortality*, though angels and human ſouls be deathleſs. In ſo incommunicable a manner does the ſuperiority of God's nature make him poſſeſs thoſe very excellencies, which the diffuſiveneſs of his goodneſs makes him pleaſed to communicate. I am the more zealous, *Lindamor*, to transfigure your love into devotion, (which I muſt deſire you to look upon but as a varied name for *Seraphick Love*) becauſe I have obſerved your paſſion to have been extremely impatient of confinement, and to have eſteemed whatever may be termed limits, to be priſons. Few therefore can need more, or deſerve better, an object for their love, for which too immenſe a vaſtneſs were impoſſible. And ſuch a one is God, whoſe ſovereign perfections render him ſo uncapable of being loved too much, that the moſt aſpiring paſſion can ſcarce arrive (ſo much as) to leſſen its diſproportion to the object. Other paſſions, like other rivers, are moſt liked, when they calmly flow within their wonted banks; but of *Seraphick Love*, as of *Nilus*, the very innundations might be deſireable, and his overflowings make him the more welcome. For mortal beauties, our paſſions are like ourſelves: if our ſtature chance to exceed a certain ſize or ſtandard, it makes us monſtrous; but devotion is like a flawleſs diamond, where the bigneſs taxes the value, and the unuſual bulk both rates and inhances the luſtre and the price.

Mat. xix. 16, 19.

2 Tim. vi. 15.

Acts viii. 17.

Luke i. 52.

Mat. xxv. 5.

Luke xvi. 8.

1 Tim. i. 17.

1 Tim. vi. 18.

To give God all our love is the greateſt command both of the law and goſpel, (in its capacious and teeming womb, both comprizing and cheriſhing all the other ſervices God requires) and that there is not more exacted of us, is not, that an addition were culpable, but becauſe it is impoſſible. So noble is the nature of devotion, that it admits of failings but by one of the extremes, which is that of defect. For, mediocrity, (whoſe office it is to reſtrain us from approaching the utmoſt limits) which in other paſſions is an excellence, is here an imperfection. Or, at leaſt, if mediocrity be that, which creates paſſions virtues, the mediocrity of this love muſt conſiſt in the boundleſſneſs of it, ſince that is it, which makes it moſt a virtue. The man after God's own heart, is not afraid to own, even to his Maker, an ardency of love for him, which muſt be expreſſed by the ſignificant metaphor of thirſt; and that ſuch a thirſt too, as makes the panting hart (by naturaliſts obſerved to be a very dry creature) *bray* (as I remember the Hebrew hath it) for thoſe refreſhing ſtreams, whoſe want diſtreſſes and reduces her to an almoſt gaſping condition: *My very ſoul* (ſaith he) *thirſteth for God*. And we know, that thirſt is not only ſo violent an appetite, that it leſſens the wonder of that monarch's bargain, whom hiſtory records to have parted with his kingdom for a cup of water; but thirſt doth ſo confine our longings to what it craves, that nothing elſe can ſatisfy them. The wealth of both the *Indies* would not excuſe the want of a needed cup, ſuppoſing their poſſeſſor tormented with an appetite, which cannot be quenched but by drink. To which I muſt add, that the uneaſineſs of unrelieved thirſt is not, like that of other inconveniences, leſſened by continuance, but grows by laſting the more unſupportable. The ſame inſpired poet ſcruples not alſo to profeſs ſo ſenſible and ſo active a concern for God's intereſts, that the *zeal of God's houſe had eaten him up*; and hugely troubled he is, that others are not affected with the ſame zeal. *I beheld* (ſays he) *the tranſgreſſors, and was grieved, becauſe they kept not thy word*. Nay, *rivers of waters*, ſays he, *run down mine eyes, becauſe they kept not thy law*. And to manifeſt how much the tenderneſs and unreſervedneſs of his love made him think thoſe his friends or enemies, that were ſo to God; *Mine eyes* (ſays he) *ſhall be upon the faithful of the land, that they may dwell with me: he that walketh perfect in the way, he ſhall ſerve me. Do not I hate them, O Lord, that hate thee, and am not I grieved with thoſe, that riſe up againſt thee? I hate them with a perfect hatred, I count them mine enemies*. At this rate did pious *David* love his Maker; but he was ſo far from thinking this rate exceſſive, that, tranſported by the ſenſe of his perſonal diſability to pay that divine object all the love, that his perfections merited, he is not content to rouſe up all his own faculties to praiſe God, (*Bleſs the Lord, O my ſoul, and all that is within me bleſs his Holy Name*,) but he invites all the godly to aſſiſt him in the payment of ſo vaſt a debt; *Love the Lord, all ye ſaints, for*, &c. And again,

Pſal. xlii. 1.

Cervina caro ſicca eſt, &c. *Sennert. Inſti. De Alimentor. facultatibus, lib. 4. part. 1. cap. 3. Verſ. 2.*

Pſal. cxix. 15. *Ibidem ver.* 136.

Pſal. ci. 6.

Pſal. cxxxix. 21, 22.

Pſal. ciii. 1.

Pſal. cxvii. 1.

Pſalm cxxxvii. 2. *Praiſe the Lord, all ye nations, praiſe him all ye people.* And not content neither frequently to do this, as may appear by very many paſſages of his ſacred poems, he extends his invitation to the angels, and all the other hoſts of God, and concludes the book of *Pſalms* with a, *Let every thing, that hath breath, praiſe the Lord.* Hallelujah.

Sect. 4. NOR does it invalidate what has now been delivered, that ſome men have, even by devout perſons, been blamed for too much devotion; for, it was not an exceſs of love, but a want of diſcretion, that was guilty of their faults: the expreſſions of our love to God ought to be regulated, not by our blind and wild fancies, but by his revealed will, (as Chriſt ſays, *if you love me, keep my commandments.*) And therefore it is very poſſible to be too devout, not becauſe any expreſſion of *Seraphick Love* can be made with too much ardency, whilſt it is conſidered abſtractedly in itſelf, and irrelatively to the reſt; but becauſe that there being ſeveral duties of love, which require an ardency of it, it is injurious to exerciſe all that in one alone, or a few, that belongs equally to the neglected others. We muſt not (as too many profeſſors are now wont to do, of whoſe error you may receive a fuller account in ſome other papers) daſh in pieces the two tables of the law againſt one another; but muſt ſo *love God with all our hearts, as to love our neighbour as ourſelves.* You know what our Saviour ſaith to the Phariſees, that tithed mint and cummin, with a neglect of judgment, mercy, and faith, thoſe weightier matters of the law; *Theſe ought you* Mat. xxiii. 23. (ἔδει) *to have done, and not to leave the other undone.* And indeed this partiality, *Lindamor*, which makes us diſplay ſo much of the ſtrength and vigour of our ſpirits in ſome favourite duties, that we can but languidly and perfunctorily perform thoſe others we are leſs fond of, begets in devotion a diſeaſe, not unlike that new one in children we call the rickets, which ſome learned phyſicians do not improbably conceive to ariſe from the unequal nutrition of the parts. For though none of them receive exceſſive nouriſhment, yet ſome of them receiving as much as is convenient for them, and thereby growing up to their natural bigneſs, whilſt others are leſs nouriſhed than (were the body healthful) they would be, do grow ſo little, that the founder parts ſeem over-grown, and ſo the diſproportion betwixt them and the ricketing ones makes the whole body they compoſe miſhapen and unwieldy. But, *Lindamor*, this proves not, that we can love God too much, but only that we may employ too much of that love, in this or that way of expreſſing it. Job iv. 19. Whilſt we are (as *Job* ſpeaks) *Inhabitants of theſe houſes of clay*, there are many duties, which do as well challenge an intenſity of our affections, as thoſe which relate more immediately 1 Cor vii. 32, 33, 34. to God. As St. *Paul* tells us, that there is difference betwixt married and ſingle perſons, the affections of the one being at liberty to devote themſelves more undiſtractedly to God, whereas thoſe of the other are diſtracted; (as *Adam*'s were betwixt his Maker and his rib.) But where a direct and immediate expreſſion of love to God defrauds not any other duty, there it is free from the danger of exceſs. Though prayers may eaſily be too long, and faſts grow exorbitant; yet Chriſt could ſpend the whole night in prayer, and faſt forty days without immoderateneſs, when the other expreſſions of his love to his Father, and the other exerciſes of his mediatory function, were not thereby diſturbed, but furthered and promoted. And ſo *Elijah* might inculpably faſt long, 1 Kings xix. 2. when that faſting did not diſable him to proſecute his journey to the mount of God; and though juſt men here on earth muſt expreſs their love to their maſter by (that buſy diſtracting, and remoter way of ſervice) trading with his talent truſted to them; yet when their diveſture of mortality diſpenſes them for thoſe laborious and avocating duties to diſtreſſed Chriſtians, and their own ſecular relations, which are here requiſite to be performed; their glorified ſpirits may now, without any immoderate devotion, employ, I ſay not, their time, but their eternity itſelf, in converſing with God, and following the Lamb whitherſoever he goes. And congruouſly I obſerve, that Rev. iv. 6, 7. the four myſterious beaſts, allowed to approach neareſt to the throne of God, though their many wings, and more numerous eyes, intimate them of a very active nature, are repreſented to us in the apocalypſe, as addicted but to one employment, ceaſing *neither day nor night from ſaying, Holy, Holy, Holy, Lord God* ver. 8. *Almighty*; and from *giving glory, and honour, and thanks unto him.* And of *thoſe that have whited their robes in the blood of the Lamb*, this account is in the ſame book given us, *that they are before the throne of God, and ſerve him* Rev. vii. 14, 15. *by day and night in his temple.* So true is it, that no degree of *Seraphick Love* can be exceſſive; nay, not any expreſſion of it immoderate, unleſs it be made ſo, not by its greatneſs, but by its uſurpation, whereby it either ingroſſes or invades what belongs to its injured and languiſhing aſſociates. Our love unto the creatures is a preſent, but unto God it is a tribute; and though we may eaſily play the prodigals in parting (over-freely) with our gifts, we can ſcarce be ſo in the payment of our debts; for, be the ſums never ſo vaſt we pay away, their being due, in ſpight of their being great, makes the diſburſement too much an act of juſtice, to be one of profuſeneſs. *Seraphick Love*, (whoſe paſſionateneſs is its beſt complexion) has then moſt approached its nobleſt meaſure, when it can leaſt be meaſured; nor ought its extent to admit any other limits, than an utter diſability to exceed thoſe that terminate it. For he alone loves God as much as he ought, that, loving him as much as he can, ſtrives to repair the deplored imperfection of that love, with an extreme regret to find his love no greater. Such a ſublimity of love will beſt intitle you to the conſolation accruing from that memorable paſſage of St. *John*, where he ſays, that *God is* 1 Joh. iv. 16. *love, and he that dwelleth in love dwelleth in God, and God in him*; which ſupplies me with a forcible inducement, to invite you to an eager aſpiring to a tranſcendency in devotion, ſince it may render ſelf-denial ſo eaſy, that it will (at laſt)

almoſt diveſt that name. For, this ſublimer love being, by an intimate conjunction with its object, wholly devoted to it, and throughly refined from all baſe droſs of ſelfiſhneſs and intereſt, nobly begets a moſt ſtrict union of our wills with God's, (or rather) a perfect ſubmiſſion of the one to the other. And thus, when it is become your will to obey his, no diſpenſations of providence will immoderately diſquiet you: for, you poſſeſs your wiſhes in general, and in bulk, though poſſibly not always in retail. For, your chiefeſt deſire being to ſee your Maker's will fulfilled, your knowledge of his being the ſovereign and uncontrouled diſpoſer of the events aſſures you, that all accidents, that can befall you, are but exact accompliſhments of his will, and conſequently of yours, ſo far forth as that is included and comprized in his. When you have reſigned, or rather conſigned, your expropriated will (if may ſo call it) to God, and thereby (as it were) entruſted him to will for you; all his diſpoſals of, and his diſpenſations towards you, are in effect the acts of your own will, with the advantage of their being directed and ſpecified by him: An advantage, that does at once aſſure you both of their rectitude and ſucceſs. God's wiſdom, power, and love to you conſidered, how much more happy muſt you be in your opinions of his chuſing for you, than your immediate own? The patient thinks himſef obliged to gratify his phyſician for chuſing for him what ſorts of meat he is to feed on; though the doctor be wont to make ſuch a choice for him, as deprives him of the diſhes he beſt likes, and oftentimes confines him to thoſe he loaths. Alas, how often might God ſay of our requeſts, as Chriſt did of thoſe of the two aſpiring diſciples, *Ye know not what ye aſk?* I admire and bluſh to read in an heathen ſatyriſt ſo heavenly a leſſon, as,

Permittes ipſis expendere numinibus, quid
Conveniat nobis, rebuſque ſit utile noſtris:
Nam pro jucundis utilia quæque dabunt dii.
Charior eſt illis homo, quam ſibi: nos animorum
Impulſu, & cæca pravaque cupidine ducti,
Conjugium petimus partumque uxoris; at illis
Notum, qui pueri, qualiſque futura ſit uxor.

'Unto the wiſer gods the care permit,
'Of what's for us and our affairs moſt fit.
'They will for pleaſant things the beſt confer;
'To whom man is than to himſelf more dear,
'We by our blinder paſſions led aſtray,
'Do for a wife perhaps or children pray;
'Which they may chance refuſe us out of love,
'Knowing what both the wife and boys would prove.

THE conſideration of which made a heathen philoſopher ſay, that he was wont only in general terms to beg good things of the gods, leaving it to them to determine what things were good for him. And indeed our own wiſhes are but too commonly as blind as *Rachel*'s, who having ſo eagerly longed for children, that ſhe impatiently cries, *give me children or elſe I die*, died in child-bearing; and as deſtructive to the wiſhers, as their longings proved to the murmuring *Iſraelites*, who loathing the wholeſome manna (that bread of angels) God had provided for them, are their own bane in the fleſh they had ſo greedily luſted for. Thus, *Lindamor*, that ſo affrighting virtue of ſelf-denial proves to be little more than a ſon's letter of attorney to his father, of whoſe paternal kindneſs and conſummate abilities in the management of affairs his confidence amounts unto a certainty. Nay, till my ſecond thoughts checked the over-forward impetuoſity of my firſt, I was about to add, ſince God reſents an infinite ſatisfaction in the accompliſhment of his own will, your making over your whole will to God will impart to you that felicity, proportioned to the degree of the reſignment. And as the eye, whilſt by the optick nerve tied unto the head, ſo changed, can taſte delights, which it is dead to, being once ſever'd from it, though (otherwiſe) it enjoy the beſt condition of which its inanimate nature can be ſuppoſed to be capable; ſo may your will, by an identity or ſameneſs (in tendency, though not in nature) with your Maker's, as it were engrafted into God's, receive a new and enlarged capacity, which will enable you to contain and reliſh joys, highly tranſcending thoſe, which the fulleſt fruition of your private wiſhes were able to create. Thus ſelf-denial is a kind of holy aſſociation with God, and (by making you his partner) intereſts you in all his happineſs and acquiſitions. And conſonantly we ſee, that glorified ſaints and bleſſed angels, whoſe will have the moſt exquiſite and exact conformity to God's, enjoy a happineſs moſt approaching his; whereas the apoſtate ſpirits, in a confirmed repugnancy to his will, find the extremity of wretchedneſs.

Gen. xxxv.

Num. xi. 33.

BUT though I dare not own, *Lindamor*, ſo bold a ſally, yet I dare without ſcruple improve the diſcourſe that preceded it, to make out to you an advantageous difference of *Seraphick Love* from ordinary flames. For, he that makes a preſent of his heart to any mortal beauty, even by her welcoming it, and lodging it with her own, grows ſubject to have it wounded in her breaſt. Thoſe misfortunes reach him, that would otherwiſe terminate in her: her afflictions torment him, whilſt his own reprieve him; and the felicity of two perſons grows requiſite to make one happy. The letting out our love to mutable objects doth but enlarge our hearts, and make them the wider marks for fortune, and capable of being wounded in more places: for, although love may as well make us participate the joys, as reſent the infelicities of the parties loved; yet even the leaſt unhappy perſons do in ſo fickle and ſo tempeſtuous a ſea, as we all find this world, meet with ſo many more either croſs-winds, or ſtormy guſts, than proſperous gales; and we are ſo much more ſenſible of pain than pleaſure, (an aching corn, though leſs than a ſickneſs, unfitting us to reliſh the otherwiſe perfect health of the whole body) that even friendſhip it ſelf, though a much calmer affection than love, ought to be declined as injurious to our quiet, did we conſider

Sect. 5.

ſider it but as a partnerſhip of fortunes, not an exerciſe of virtues. But he, whoſe wiſer love ſettles it ſelf on God, is not only, by the immutable, and even eſſential happineſs of that adorable object, ſecured from participated infelicities; but finds his perſonal croſſes and diſtreſſes ſweetened by conſidering, that what he moſt loves is moſt happy, and as able as willing in due time to make him ſo. And though *Seraphick Love* make us partake but God's felicities, yet his acceptance of it makes him reſent our ſorrows. *In all their afflictions he was afflicted*, ſays the prophet of God, and of the Iſraelites. And ſo the Son of God, (who is ſo much one with thoſe that love him, that both he as the head, and they as the members, are ſometimes, as making up one body, called by one name, Chriſt) though as high as heaven, above the reach of perſonal or immediate perſecutions, called out to *Saul* for an intention of harming thoſe that loved him, *Saul, Saul, why perſecuteſt thou me?* and to demonſtrate the tenderneſs of this compaſſion, the prophet ſays to the returned Iſraelites, concerning God, *He that toucheth you, toucheth the apple of his eye.* Nor is God's compaſſion like a miſtreſs's, a grieving only, and an uſeleſs pity, whereby the ſuffering lover is oftentimes leſs comforted, as it proceeds from her kindneſs, than afflicted, becauſe it breeds her diſquiet; but God's is a compaſſion, though active, yet ſerene, and worthy of himſelf, which without producing the diſcompoſure, produces the effects of the moſt ſenſible pity, by engaging him to a timely relief and reſcue: as that freſhly mentioned expreſſion, *In all their afflictions he was afflicted*, is immediately followed by, *and the angel of his preſence ſaved them; in his love, and in his pity he redeemed them, and he bare them and carried them all the days of old.* Yes, this pity, for its not diſturbing God's happineſs, inclines him not the leſs to expreſs a ſenſe of our miſeries, and makes us find (to uſe a ſcripture phraſe, as I would render it) χάριν εἰς εὐκαιρον βοήθειαν (*grace for an opportune relief,*) I ſay, with the divine writer, *an opportune* or *ſeaſonable relief*; becauſe it comes not always when it is moſt deſired, but when it is moſt fit; and when that is, he that hath at once all preſent, paſt, and future things in his proſpect, is fitteſt to determine. Chriſt's words to his diſciples, *It is not for you to know the times or the ſeaſons, which the Father hath put in his own power*, are applicable to more caſes than that which occaſioned them. The Canaanitiſh woman muſt put up a refuſal, and the reproachful name of a dog, (which yet, by the way, was a paraphraſe commonly enough uſed by the Jews of the heathen, and as ſuch was underſtood by this Ἑλληνίς Gentile not Greek.*) The Iſraelites (compriſing the patriarchs their progenitors) were reduced to wait four hundred and thirty years, ere they were introduced into the promiſed land; and during a great part of that long ſpace of time, languiſhed and groaned under the heavy burdens, and other as heavy preſſures of the as cruelly as unſucceſsfully politick Egyptians.

Iſai. lxiii. 3.

1 Cor. xii. 12.

Zech. ii. 8.

Heb. iv. 16.

Acts i. 7.

Mat. vii. 27.

Gal. iii. 17.

St. *Paul* himſelf prayed the Lord thrice for the removal of that rude σκόλοψ τῇ σαρκὶ, *thorn to the fleſh* (whatever that may mean.) Nay, of the bleſſed virgin-mother her ſelf, her divine Son would not be found 'till the third day, though ſhe ſought him ſorrowing. And *Lazarus*, to whom, even during his ſickneſs, he vouchſafed (a title, to which all *Cæſar*'s were but trifles) the ſtyle of friend, which emboldened the pious *Mary* to paraphraſe him by a *he whom thou loveſt*, was permitted not only to lie a dying, but to die; his reſcue being deferred, till it was thought impoſſible, and was ſo indeed to any leſs power than omnipotence. Which manifeſts, that as no degree of diſtreſs is unrelieveable by his power, ſo no extremity of it is inconſiſtent with his compaſſion, no not with his friendſhip. He, whoſe ſpirit inſpired the prophets, is in the laſt of them repreſented under the notion of a refiner: and it is not the cuſtom of refiners to ſnatch the beloved metal out of the fire, as ſoon as it feels the violence of that purifying element; nay, nor as ſoon as it is melted by it, but they let it long endure the brunt of the active flames, actuated by exciting blaſts, till it have ſtood its due time in the fire, and there obtained its full purity and ſplendor. And I hope, you will give one, that converſes with furnaces, though he be no pretender to the philoſopher's ſtone, leave to implore a chymical metaphor, and obſerve, that though in afflictions, eſpecially national or publick calamities, God oftentimes ſeems to make no diſtinction betwixt the objects of his compaſſion, and thoſe of his fury, indiſcriminately involving them in the ſame deſtiny; yet his preſcience and intentions make a vaſt difference, where his inflictions do not ſeem to make any: as when on the ſame teſt, and with the ſelf-ſame fire, we urge as well the gold, as the blended lead, or antimony; but with fore-knowing and deſigning ſuch a diſparity in the events, as to conſume the ignobler minerals, or blow them off into droſs or fumes, and make the gold more pure and full of luſtre.

Ezekiel xxviii. 24. 2 Cor. xxxii. 7. Luke ii. 48.

Joh. i. *ver.* 3.

Mal. iii. 3.

Sect. 6.

It is true, *Lindamor*, and (not to be ſuſpected of partiality towards a love, which ſo little needs it to be thought fit to be preferred before all other paſſions) I ſhall acknowledge it, that the happineſs reſulting from thoſe many prerogatives I have endeavoured to diſcover to you in a tranſcendent degree of *Seraphick Love*, is moderated by the effects of that ſublimity, the eager deſires it creates of a more compleat fruition, of its perfect and divine object. Such aſpiring ſallies of the longing ſoul made the languiſhing ſpouſe in the *Canticles* cry out, *Stay me with flagons, comfort me with apples, for I am ſick of love.* Such made the raviſhed apoſtle deſire to return (for ſo I ſhould rather tranſlate the word, ἀναλῦσαι, there, and ſo I find it * elſewhere to ſignify) *and to be with Chriſt:* and the inſpired poet thus expreſſes his longings to the bleſſed object of them, *As the hart panteth after the water-brooks, ſo panteth my ſoul after thee, O God. My ſoul thirſteth for God, for the living God:*

Cant. ii. 5.

Phil. i. 23.

* Luk. xii. 36.

Pſal. xli. 1, 2.

when

* The text refers her extraction to *Syrophœnicia*, the ſame region with *Canaan*.

when ſhall I come and appear before God? But, *Lindamor*, it was fit, that to elevate our thoughts and wiſhes to heaven, ſome peculiar, and elſewhere incommunicable degree of joy ſhould be reſerved for us there. And it is a good ſign, and ſuch as worldly objects cannot boaſt, when the incompleatneſs of our *Seraphick Lover*'s happineſs, in his fruitions, proceeds not from their want of ſatisfactorineſs, but his want of an entire poſſeſſion of them. And let me tell you, *Lindamor*, that even this uneaſy ſtate of ſeparation is ſweetned with as much allay as is conſiſtent with its being a grief. For, the divine evidence and teacher of God's love pronouncing a thirſt after perfection to be a title to it, (according to thoſe Mat. v 6. Scriptures, *Bleſſed are they that hunger and thirſt after righteouſneſs; for they ſhall be ſatisfied:* and, *Let him that is athirſt come, and* Rev. xxii. 17. *whoſoever will, let him take of the water of life freely*) and the joys of heaven being ſo vaſt, that they diffuſe their nature to all the grounded hopes men have to obtain them; each new aſſurance is a new degree of them, and is acceptable to our hope, though uneaſy to our deſires. And theſe baitings at compleat felicity ſhould not be more unwelcome for the preſent diſquiet they ſuppoſe, than the contrary for the zeal they argue, and the felicity they promiſe. For this production of the ſpirit in our hearts may be juſtly termed as the 2 Cor. v. 5. Spirit himſelf in ſcripture is, an earneſt; which though, by being ſuch, it confeſſes it ſelf not to be the entire ſum, yet it is not only a part of it, but a pledge: and, *Lindamor*, how ſupportable is this thus qualified allay of the joys of *Seraphick Love*, in compariſon of the diſquiets, and the torments, that are wont to attend ſenſual love? I ſhall not loſe [time] to enumerate how many it is ſuppoſed to have ſent to their graves; becauſe, though I find thoſe tragical ſtories rife enough in romances, yet I find them rarities every where but in thoſe fabulous compoſures: and though I have had the curioſity to viſit ſome of thoſe warmer regions, where the flames of love are thought to burn with more violence, yet (bating the duels and the pox) I remember not to have obſerved love to have ever been the death of any man; unleſs, ſpeaking like philoſophers, who make reaſon the eſſential conſtituent form of a man, we will affirm, that love, by dethroning reaſon, though it leave the lover alive, doth kill the man. But, though I am loth to put ſo bad a compliment upon mankind, as to ſay, that love is wont to deſtroy mens lives; yet I think it would be no calumny to ſay, it much diſquiets them. I could aſk you, how long many a lover muſt continue a ſervant, to purchaſe the honour of being taken notice of to be ſo? And I could recruit that queſtion with pretty ſtore of others of the like nature; but that I ſuppoſe your memory will ſave my pen the labour of repreſenting to you the torments of love, which they that feel them, would little leſs juſtly than they do frequently ſtyle martyrdoms, if the greatneſs only, without the cauſe and object of men's ſufferings, ſufficed to make them martyrs. And though the condition of lovers be in romances ſo dexterouſly and delightfully deſcribed, that not only ſanguine readers are tranſported, but even I my ſelf have been ſurprized into inclinations, to admire and envy their felicity; yet when ſome, I was concerned for, have been really concerned and engaged in ſome adventures, my envy quickly turned into pity. For, the repulſes, the regrets, the jealouſies, the fears, the abſences, the deſpairs, and the reſt of the afflicting diſquiets of lovers; though in well-writ romances they are ſoon read over by the diverted peruſer, yet they are not ſo ſoon weathered out, nor ſo eaſily ſupported by the diſconſolate lover; whoſe infelicities, though they may be perhaps ſo handſomely deplored, as to delight the reader, yet truſt me, *Lindamor*, it is a much happier condition to be free from misfortunes, than to be able to complain eloquently of them. And as I have with delight beheld a ſtorm excellently drawn by ſome rare artiſt's pencil; but when I was this ſpring toſt by the rude winds, that blew me out of *Holland*, I found a real ſtorm a very troubleſome and uneaſy thing: ſo the condition of a lover, though drawn by a ſmooth pen, is wont ſtrangely to affect and pleaſe us; yet when men are really engaged in it, they find it full of hardſhips and diſquiet. It is a much better condition to be looked on than embraced; and experience gives men of it much (ſadder and) more unwelcome notions than deſcription did. Nor fancy, *Lindamor*, that the troubleſomeneſs of your ſufferings in love proceeded but from their not being acceptable to her, for whom you endured them; for had your miſtreſs crowned them with myrtle, and proved as kind to you as *Hymen* could have made her, yet, I fear, ſhe could have recompenſed you but by diſabuſing you, and could not have freed you from the need of happineſs, but only from a miſtake concerning it. For, methinks, *Lindamor*, moſt of theſe tranſitory goods, that we are ſo fond of, may not unfitly be reſembled to the ſenſitive plant, which you have admired at *Sion-garden*; for as, though we gaze on it with attention and wonder, yet, when we come to touch it, the coy deluſive plant immediately ſhrinks in its diſplayed leaves, and contracts it ſelf into a form and dimenſions, diſadvantageouſly differing from the former; which it again recovers by degrees, when touched no more: ſo theſe objects, that charm us at a diſtance, and whilſt gazed on with the eyes of expectation and deſire; when a more immediate poſſeſſion hath put them into our hands, their former luſtre vaniſhes, and they appear quite differing things from what before they ſeemed; though after deprivation or abſence hath made us forget their emptineſs, and we be reduced to look upon them again at a diſtance, they recover in moſt men's eyes their former beauty, and are as capable as before to inveigle and delude us. I muſt add, *Lindamor*, that when I compare to the ſenſitive plant moſt of theſe tranſitory things, that are flattered with the title of goods, I do not out of that number except moſt miſtreſſes. For, though I am no ſuch an

enemy to matrimony, as ſome (for want of underſtanding the raillery, I have ſometimes uſed in ordinary diſcourſe) are pleaſed to think me, and would not refuſe you my advice (though I would not ſo readily give you my example) to turn votary to *Hymen*; yet I have obſerved ſo few happy matches, and ſo many unfortunate ones; and have ſo rarely ſeen men love their wives at the rate they did, whilſt they were their miſtreſſes; that I wonder not, that legiſlators thought it neceſſary to make marriages indiſſoluble, to make them laſting. And I cannot fitlier compare marriage than to a lottery; for in both, he that ventures may ſucceed, and may miſs; and if he draw a prize, he hath a rich return of his venture: but in both lotteries there lie pretty ſtore of blanks for every prize. And for your particular, *Lindamor*, the world is much miſtaken in both your humours, if *Hermione*'s and yours be not ſo unſuitable, that (to make haſte from ſo nice a ſubject) had ſhe juſtified your expectation of her kindneſs, you would have poſſeſſed the perſon without poſſeſſing the happineſs you expected; and might have found your ſelf as ſenſibly diſappointed by her grant, as you were by her change.

But I forget, *Lindamor*, that I reſolved not to inſiſt on parallels; and therefore, inſtead of proſecuting the diſcourſe my pen has ſlipt into, concerning the advantages of *Seraphick*, compared with ordinary love, I ſhall venture to encourage you to the former, by ſhewing you, that your paſt addictedneſs to the latter may prove ſerviceable to you in it. Yes, *Lindamor*, I ſhall not ſcruple to tell you, that your ſtrong paſſion for *Hermione* may not a little facilitate your devotion, partly by breaking all the chains, excepting one, that faſtened your affection to unſatisfying objects, and reſtrained it from ſoaring to the ſublimeſt; and partly, by exalting your paſſion to a height fit for ſeraphick flames. For love hath this of noble, that it makes us diveſt our ſelves of ſelfiſhneſs, ſlight fortune, quiet, ſafety, honour, life, and all our own concernments, when their coming into competition with the loved party's intereſts, may render their ſacrifice acceptable to her; and makes us think goods or ills deſerve thoſe names, but as they come to us from or through her. You could ſcarce have learned a better leſſon, even from a much better maſter; for love having thus accuſtomed you to (what is thought moſt difficult in that virtue) the acts of ſelf-denial, you need almoſt but transfer your flames from an inferior and miſtaken to their true and nobleſt object, and you will have exalted and refined your love into devotion; to the latter of which a ſublime elevation of the firſt is ſuch a diſpoſition, as the having formerly by looſer airs and (perchance) wanton ſongs, learned to improve and to command one's voice, is, to the ſkill of ſinging thoſe devout hymns and heavenly anthems, in which the church militant ſeems ambitious to emulate the triumphant, and eccho back the ſolemn praiſes and hallelujahs of the celeſtial quire. And, as by hunting, though (poſſibly) we follow but ſome poor fugitive hare, or ſome ſuch trifling game, we gain that vigour, that ſufferance, and agility, that fits us for the toils and military hardſhips that are exacted in the purſuit of glory, and of empire: ſo though in love (devotion's prenticeſhip) the courted creature be often conſiderable enough to make our elections fit to be numbred among ſuch as thoſe that made love be painted blind; yet in the progreſs and conduct of our paſſion, we contract ſuch diſintereſted and reſigned habitudes, as, being preferred to ſerve celeſtial objects, do excellently qualify us for devotion. And in effect, a fervent love ſeems little elſe than devotion miſaddreſſed, where our own very expreſſions may ſerve to diſabuſe us: for, when you give your miſtreſs the ſtyle of goddeſs, and talk of nothing to her, but offering up of hearts, adoring, ſacrifices, martyrdoms; does not all this imply, that though it be ſaid to her, it is meant to a divinity: which is ſo much the true and genuine object of men's love, that we cannot exalt that paſſion for any other, without inveſting it with the notion and attributes of God? as children diſcloſe the inbred kindneſs they have for thoſe perſons, by calling the babes they moſt doat upon by their dear mother's, or loved nurſe's names. And as *Aaron*, and the revolting Jews, by juſtifying to themſelves their adoration of the idols they had ſet up, by attributing the title of God to what they adored, did tacitly acknowledge adoration to be due only to the Deity; ſo does a lover, by naming what he worſhips a divinity, tacitly confeſs the Deity to be the proper object of that higheſt and peculiar ſtrain of worſhip.

Ex. xxxii. 4, 5. *In the latter of which it is expreſly ſaid that the feaſt was proclaimed* יהוה *To* Jehovah, *the peculiar name of the true God.*

And this truth, *Lindamor*, the very fickleneſs of lovers concurs to teſtify: for, what men call, and think inconſtancy, is nothing but a chace of perfect beauties, which our love fruitleſly follows and ſeeks in ſeveral objects, becauſe he finds it not entire in any one. For creatures have but ſmall and obſcure fragments of it, which cannot fix, nor ſatisfy an appetite, born for, and (though unwillingly) aſpiring unto God; who is proclaimed the true and proper object of our love, as well by men's fickleneſs to women, as the angel's conſtancy to him. Juſt as the trembling reſtleſsneſs of the needle, in any but the north point of the compaſs, proceeds from and manifeſts its inclination to the pole; its paſſion for which both its wavering and its reſt bear equal witneſs to. That unſatisfiedneſs with tranſitory fruitions, that men deplore as the unhappineſs of their nature, is indeed the privilege of it; as it is the prerogative of men not to care for, or be capable of, being pleaſed with whiſtles, hobby-horſes, and ſuch fond toys as children doat upon, and make the ſole objects of their deſires and joys. And by this you may, *Lindamor*, in ſome degree imagine the unimaginable ſuavity, that the fixing of one's love on God is able to bleſs the ſoul with; ſince, by ſo indulgent a father, and competent a judge as God himſelf, the decreed uncontentingneſs of all other goods is thought richly repaired by its being but an aptneſs to prove a riſe to our love's ſettling there. *Sect.* 8.

And

Sect. 9. AND hitherto, my deareſt *Lindamor*, I have endeavoured to recommend unto you *Seraphick Love*, by mentioning ſome of its properties, which ſeem to relate more to the love itſelf, than to the divine object of it. But I fear you'll think I have too long entertained you with conſiderations, which, beſides that they are not altogether the importanteſt that belong to this diſcourſe, I have been by haſte reduced to pen in the unaccurate order, wherein they offered themſelves to my thoughts, not the method, wherein I ſhould have preſented them to yours.

Sect. 10. AND therefore, *Lindamor*, ſince the nobleſt and ſupreme motives to the love of God conſiſt in his own infinite perfections and prerogatives; and ſince the properties of God's love to us do advantage us much more, (and conſequently are likelier to endear devotion to us) than thoſe of ours to him; the former not only moving God to kindle in us, but to cheriſh and foment, and (if our own wilful extinction interpoſe not) to crown the latter: for both theſe reaſons, I ſay, *Lindamor*, I doubt not, but you'll think it ſeaſonable for me to proceed, to conſider that higher ſort of motives to devotion, and to evince, that the ſeveral things, which are wont moſt to engage and heighten our affections, do, in a peculiar and tranſcendent manner, ſhine forth and conſtellate in God. That, you know, which enamoured you of *Hermione*, I need not prove to you, to have been your ſuppoſing her full of lovelineſs and excellencies in her ſelf; and your believing, that the love ſhe vouchſafed you was great, free, conſtant, or advantageous to you. And that all theſe properties do not only eminently exiſt, but illuſtriouſly concur in God, and his love, I muſt now, *Lindamor*, (with ſtrong deſires of doing it proſperouſly) attempt to manifeſt.

Sect. 11. FIRST then, our higheſt love is made God's due by the excellency and prerogative of his nature. But, truſt me, *Lindamor*, when (neceſſitated by a method exacted by the nature of this diſcourſe) I find my ſelf engaged to ſay ſomething by way of celebration of God's perfections; I am very ſenſible, I can but detract from what I deſire to praiſe, and muſt inevitably appear unable to ſpeak worthily of a theme, to which even Seraphim themſelves cannot do right. And if, as the ſcripture aſſures us, thoſe things never fell under the ſen-
1 Cor. ii. ſes, nor entered the thoughts of men, which God has reſerved for thoſe that love him; how ineffable and incomprehenſible muſt thoſe things be, which he has reſerved for himſelf? the infinite ſuperiority of his nature, above all created beings, placing a vaſt diſparity betwixt his greateſt communicated vouchſafements, and his boundleſs, and therefore to creatures incommunicable, perfections.

WONDER not therefore, *Lindamor*, that my weak eyes dare not dwell long upon an object, which they cannot ſtedfaſtly gaze on long without being dazzled; and do not marvel, that I ſcruple not to uſe ſeeming hyperboles, in the mention of perfections, which make the higheſt hyperboles but ſeeming ones; both God's nature and his word declaring him to be *exalted above all bleſſing and praiſe*. If it were ſeaſonable, *Lindamor*, to entertain our ſelves but with thoſe attributes of God, which are legible or conſpicuous in the creation; we might there diſcern the admirable traces of ſuch immenſe power, ſuch unſearchable wiſdom, and ſuch exuberant goodneſs, as may juſtly raviſh us to an amazement at them, rather than a bare admiration of them. And I muſt needs acknowledge, *Lindamor*, that when with bold teleſcopes I ſurvey the old and newly diſcovered ſtars and planets, that adorn the upper region of the world; and when with excellent microſcopes I diſcern, in otherwiſe inviſible objects, the unimitable ſubtilty of nature's curious workmanſhip; and when, in a word, by the help of anatomical knives, and the light of chymical furnaces, I ſtudy the book of nature, and conſult the gloſſes of *Ariſtotle*, *Epicurus*, *Paracelſus*, *Harvey*, *Helmont*, and other learned expoſitors of that inſtructive volume: I find my ſelf oftentimes reduced to exclaim with the *Pſalmiſt*, *How manifold are thy works, O Lord? in wiſdom haſt thou made them all!* And when I have been loſing my ſelf in admiration of what I underſtand not, but enough to admire, and not to comprehend; I am often obliged to interrupt or break off my inquiries, by applying to the works of God's creation the expreſſion uſed by St. *Paul*, of thoſe of his providence, *O the depth of the riches, both of the wiſdom and knowledge of God! how unſearchable are his judgments, and his ways untraceable!* And exclamations of this nature may the attentive conſideration of any other of God's attributes deſervedly produce. But having elſewhere treated of this ſubject in a peculiar diſcourſe, I ſhall now, *Lindamor*, invite you to conſider with me, how much you, and thoſe that are conſcious to their having virtue enough in themſelves, to make them prize it in others, are in love with *Cato*, *Scipio*, and thoſe other heroes, that did ennoble, and almoſt exceed mankind, upon the bare knowledge of their virtues; although from them we derive no perſonal advantage, (their death having numerous ages preceded our nativity.) Since then we pay ſo much diſintereſted love to ſome few faint and ill-refined virtues, that never did profit us; how much on ſuch a ſcore, and at that rate, ſhould we love him, who ſo poſſeſſes all perfections, that each of his perfections is infinite? Were you and I our own creators, *Lindamor*, and wholly independent upon God, without either need or hope to taſte his bounty; his native excellencies, and what he has done for others, ſhould ſurely raviſh us, and enamour us of him. Though his benefits to us did not entitle him to our love, his eſſence (the ſource and only motive of thoſe benefits) would give him a right to it; and though we owed him nought for what we are, we yet ſhould owe him love for what he is. He is that glorious ſun, from whom (as beams) all created perfections flow, and in whom they all concentre. To omit God's ſovereign majeſty, (which places him ſo high, that but to own for him ſo familiar and level-
Neh. ix. 5.
Pſal. civ. 24.
Rom. xi. 33.

ling

ling an affection as love, much more to expect to be re-loved by him, were not the leaſt ſaucy preſumption man could be guilty of, did not his own commands make it a duty;) not to inſiſt on this. I ſay, let us a while conſider that proper and peculiar attraction of love, his lovelineſs; which is ſuch, that, did we but once ſee it, all creature-competitions (even we being judges) would then be as impoſſible as they are now unjuſt. In the fifth Iſa. vi 7. Evangeliſt's prophetick viſions, the Seraphim themſelves (thoſe glorious ornaments of the celeſtial hierarchy) are repreſented as covering their faces in God's preſence, either bluſhing at their comparative deformity, or unable to ſuſtain the unqualified ſplendor of ſo divine brightneſs; whence perhaps it became of old the Jewiſh faſhion (as ſome frequent expreſſions in their writers intimate) when they went to pray, to veil their heads and faces; (though now I have in their ſynagogues ſeen them only cover their heads, not their faces, with thoſe white garments they wear at their publick devotions.) And, *Lindamor*, if *Moſes*'s face, by but a few days converſe with God, reflected ſuch a light as dazzled mortal eyes; and if his ſwift poſts, the angels, when ſent on errands to us here on earth, even when they may be ſuppoſed (if I may ſo ſpeak) to wear their travelling clothes, and ſtood as much to our frailty in the form, as the region, they appear to us in, do, in ſpite of that darkening condeſcenſion, ſo much tranſcend all objects here on earth, that the ſcripture often mentions, that even thoſe, that aſpired to imitate their virtues, were confounded at their preſence: And if, in this veiling habit, they appear ſo glorious, that their thus diſadvantaged beauty is made the compliment and hyperbole of that quality; what may we, or rather, what may we not conclude of God himſelf, of whom the Pſal. xciv. 9. ſcripture ſays, *He that planted the ear, ſhall he not hear? he that formed the eye, ſhall he not ſee?* That is, he, that imparts a faculty, or an excellence to the creature, ſhall not he himſelf much more eminently poſſeſs it? And in effect, the moſt unblemiſhed created beauties are but faint ſhadows (or trulier, foils) of his. Thoſe drops of prettineſs, ſcatteringly ſprinkled amongſt the creatures, were deſigned to defecate and exalt our conceptions, not to inveigle or detain our paſſions: for God did never intend them to terminate our love, but only by our eyes to exalt our faith above them, and by the beauties our ſight can apprehend to raiſe us to a confidence, that there is in their author more than we can either ſee or comprehend. 2 King ii. 11. Like *Elijah*'s fiery chariots, though they be pure and bright, and conſiſt of the nobleſt and glorioſeſt materials, they are meant by God Gen xxiv. 10--53. but to carry us up to him. And as the patriarch's ſteward was furniſhed with ſo ſumptuous an equipage to court *Rebecca*, not for himſelf, but for *Iſaac*; ſo all the lovelineſs imparted to the creature is lent it, but to give us ſome more enlarged conceptions of that vaſt confluence and immenſity, that exuberates in God. To make the righteſt uſe of fading beauties, you muſt conſider God and them, as you were wont to do your miſtreſs's picture and its cryſtal cover: where, though that native glaſs were pure and lovely, and very richly edged, yet to gaze on it was not the chiefeſt buſineſs of your eye; nor did you in it terminate your ſight, but greedily look through and beyond it, upon the adored image, that ſolid veil betrayed. Methinks, *Seraphick* and our common lovers behold exterior beauties with a difference reſembling that, wherewith children and aſtronomers conſider *Galileo*'s optick glaſſes, (with one of which teleſcopes, that I remember I ſaw at *Florence*, he merrily boaſted, that he had *trovato la corte a Giove*;) which the one prizes moſt for what they appear; the other, for what they diſcover. For children contenting themſelves to wonder at the length, and fall in love with the workmanſhip and gildings of the tube, do thus but gaze upon them; whereas aſtronomers look through them, and, ſcarce taking notice of the unuſual ornaments, or the ſhape, employ them to find out unknown lights in the ſky, and to deſcry in heaven bright ſtars, unſeen before, and other celeſtial novelties and beauties.

I DENY not, *Lindamor*, that God has been *Sect.* 12. pleaſed to adorn ſome of his creatures with hints and impreſſes, as well of his lovelineſs as his other excellencies; but they do much more faintly and imperfectly reſemble him, than the counterfeit ſun we ſometimes ſee in a cloud emulates the true one, by whoſe refracted and reflected beams, ſome acute modern naturaliſts ſuppoſe it to be produced. For though this derivative ſun ſhine with a not-inconſiderable luſtre, comparatively to the reſt of the dark cloud it ennobles; yet is it not only as much inferior to the true ſun in brightneſs, as in height, but it enjoys alone a precarious, dependent, and almoſt momentary being, which often it loſes in a very ſhort time, and never attains to preſerve a very long one. And therefore, to neglect that ſupreme reſplendency, that ſhines in God, for thoſe dim repreſentations of it, that we ſo doat on in the creature, is as prepoſterous and abſurd, as it were for a Perſian to offer his ſacrifice to a parhelion, (as the Greeks call that meteor) inſtead of adoring the ſun. And certainly, *Lindamor*, if our dim ſight, like that of the prophet's ſervant, who ſaw the mountains near *Dothan* covered with 2 Kings vi. horſes and chariots of fire, were privileged to 17. diſcern otherwiſe inviſible objects; our raviſhed eyes would behold lovelineſs enough in God, to make us inceſſantly exclaim in the language of the prophet, *How great is his good-* Zech. ix. *neſs, and how great is his beauty!* Agreeably 17. whereunto we may obſerve, that as the loadſtone doth attract moſt powerfully the brighteſt needles, made of the pureſt ſteel, and thoſe that moſt approach it; ſo angels, who, of all created beings, enjoy the unclouded'ſt light, and the moſt clear knowledge of their Maker, do love him with a conſtancy ſo fixed, that in five thouſand and ſome odd centuries of years, (effluxed ſince the creation) they could never ſee any thing, either in God, or out of him, capable to ſeduce them to a change; God's lovelineſs (which is ſuch, that the eternal fruition

of himſelf creates even his felicity) is like rare muſick, which, though it do delight all its partakers, the knowingeſt artiſts ſtill do higheſt value, and are moſt raviſhed with the tranſports it produceth, being proportioned to the degrees of the ſkilfulneſs of its admirers. The apoſtate ſpirits indeed deſerted their firſt ſtation, not frighted thence by any blemiſh they deſcried in God; but probably fell by a ſaucy affectation of a parity; and (as divines tell us) a ſacrilegious aſpiring to perfections, which they were criminally unable to behold, without wiſhing them their own. And for their preſent ſeparation from God, it is their curſe and puniſhment. And I ſhall ingenuouſly confeſs to you, *Lindamor*, that by the advantageous ideas I entertained of God's perfections, I have been ſometimes inclined to think, that the reaſon why God tells *Moſes*, *Thou canſt not* Exod. xxxiii. 20. *ſee my face, for there ſhall no man ſee me and live*, might be, that as tranſcendent objects deſtroy the ſenſe, ſo lovely and glorious a ſight, (whoſe continuance ſhall make our happineſs in heaven) would let in joys, and would create deſires, too mighty for frail mortality to ſuſtain. The raviſhed ſoul being ſhewn ſuch game as that, would hate ſo eagerly, that ſhe would break thoſe leaſhes, that tie her to the body, (and thereby hinder her flight to that wiſhed union;) and the glad heart, (too narrow a receptacle for ſo much joy) to make room for ſuch gueſts, would ſtretch unto a rupture. Longing or joy have ſometimes ſingly reached degrees, that have made them fatal; and why then ſhould their union, in ſuch extremes, be thought uncapable of producing the like effect? Nor is it, perchance, more a privilege of the next life, that we ſhall then ſee God, than that we ſhall ſurvive that glorious ſight; which is too dazling an object for mortal eyes, till (to uſe 1 Cor. xv 54. St. *Paul*'s expreſſion) *our mortal ſhall have put on immortality*. But I muſt no longer loſe my ſelf in a theme, on which it is ſo eaſy to ſpeak much, and ſo impoſſible to ſay enough. If I be not very much miſtaken, they are ſo, who preſume to give us ſatisfactory definitions of God's nature, which we may perhaps more ſafely define by the impoſſibility of its being accurately defined. And I muſt confeſs, I do the leaſt expect the beſt deſcription of the divine nature from thoſe, that are moſt forward to take upon them to explicate it; for our words being but the repreſentations of our notions, and they being neceſſarily finite, as our being; few men are (methinks) more likely to be miſtaken in the nature of what is infinite, (and conſequently of God's attributes) than thoſe that think deſcriptions can comprize it. Nor will an aſſiduity and conſtancy of our ſpeculations herein relieve us; for too fixed a contemplation of God's eſſence does but the more confound us. As I remember St. *Paul* Acts xxii. 6, 11. tells the *Jews*, that *he could not ſee for the glory, or that light*, that ſhone from heaven about him at his converſion. And this the famous *Simonides* experimentally found, who being aſked what God was, took a day's time to conſider of it; after being called upon for his anſwer, he deſired two days longer to think upon it; and, when they were expired, demanded four days longer; and ſo continued a great while, each time increaſing his demands for reſpite, till, being preſt to give an account of ſuch a dilatory way of proceeding, he ingenuouſly acknowledged, that the longer he conſidered God's nature, the leſs he comprehended it. And indeed, experience teaches us, that they, that gaze ſtedfaſtlieſt on the noonday's ſun, can leaſt of all diſcern what it is, being rather dazzled than inſtructed by ſo confounding an object. Nor, is it only, *Lindamor*, a taſk of too great difficulty for a mere man, perfectly to explicate that incomprehenſible nature of God, to which nothing but his own infinite underſtanding can be adequate; but, methinks, even to celebrate God's perfections, cannot be ſoberly attempted, without a very deep ſenſe of a man's own unworthineſs and incapacity. For, the ſame excellencies, that furniſh us with praiſes, do tranſcend them. And the fruitfulneſs of the ſubject may as well deter, as invite our pens; ſince, as we are ſure we ſhall not want theme, ſo we are certain we cannot dignify it. And for my part, *Lindamor*, though my ſubject exacted of me the praiſes I have endeavoured to aſcribe to God, yet I ſhould have thought it rather to decline the laws of method, than be reduced to derogate from what I would extol; if the neceſſity of detracting from God's perfections were not equal to that of mentioning them; and if that neceſſity were not as glorious to God, as greater praiſes than we are able to aſcribe him, could be. But, *Lindamor*, having thus done right to my method, though I could not to my theme, I ſhall only invite you to imitate with me thoſe Perſians, that adored the ſun, thought the light he lent them ſerved but to make the ſource of it admired, and not to pry into his abſtruſe eſſence with it. And though I might ſay much more concerning God's perfections, I muſt henceforth think ſilence the propereſt language I can now employ; for it is ſilence, that beſt expreſſes our wonder: and ſure, wonder is never more ſeaſonable than when God is the object; a proſtrate veneration being the ſafeſt apprehenſion of him, that is incomprehenſible.

HAVING thus conſidered, *Lindamor*, how *Sect.* 13. fit an object God is of our higheſt love for what he is in himſelf; let us now proceed to derive further proofs of the ſame truth from what he is to us, (that your gratitude may contend with your reaſon, which ſhall moſt heighten your devotion) and we ſhall find in the vaſtneſs, freeneſs, diſintereſtedneſs, conſtancy, and advantageouſneſs of his love to us, that more than all the love we can pay him were but a little part of that we owe him.

BUT for the firſt attribute, we have aſſigned his love, (the greatneſs of it) it being a general property, diffuſed through all the reſt, and conſpicuous in them, it requires now to be treated of apart.

WE ſhall then proceed to the freeneſs or unmeritedneſs of God's love; to believe which ſtrangely vaſt, we need but conſider, that we ſo little could at firſt deſerve his love, that he

loved us even before we had a being; and our felicity in his degrees preceded our exiſtence in this world. God loved you numerous ages before you were; and his goodneſs is ſo entirely its own motive, that even your creation (ſince when, alone you can pretend to merit his love) is the effect of it. This benefit alone were ſufficient to render God the object of our love, though we were that of his averſion. For (as the Perſians adored the ſun even when it ſcorched them) we eſteem ourſelves obliged to love and honour our parents, in ſpight of their being wicked and unkind, though they be but God's inſtruments in our production, and made us what we were born, not arbitrarily, but in virtue of his ordination. But God, to confer on us, in the moſt excellent and endearing manner, the bleſſing promiſed to his ancient people, when he vouchſafed to aſſure them, that *he would love them freely*, was pleaſed to love us, not only when we were not at all, but when we were his enemies; *If when we were enemies* (ſaith St. *Poul*) *we were reconciled to God by the death of his Son*, &c. Our inexiſtence indeed was a condition, wherein nothing in us was capable of being a motive of God's love: but our enmity proceeded farther, and made us worthy of his deteſtation; as if his love were nothing unleſs it vanquiſhed obſtacles, as well as wanted motives. This gave the Apoſtle a juſt cauſe to ſay, that *God commendeth his love towards us, in that while we were yet ſinners Chriſt died for us*: that is, when we wanted all motives to invite his love, unleſs our very want of them ſhould paſs for one. And how did God expreſs his love unto us? even by the gift of the Son of his love; *For God ſo loved the world*, (ſays the divine token of his love) *that he gave his only begotten Son*. And how did that Son love it? *He* (ſays the Apoſtle) *being in the form of God, thought it no robbery to be equal with God; but made himſelf of no reputation, and took upon him the form of a ſervant, and was made in the likeneſs of men. And being found in faſhion as a man, he humbled himſelf, and became obedient unto death, even the death of the croſs*. That is, that he would love at no leſs rate than death; and, from the ſupereminent height of glory, ſtooped and abaſed himſelf to the ſufferance of the extremeſt of indignities, and ſunk himſelf to the bottom of abjectedneſs, to exalt our condition to the contrary extreme. *He was wounded for our tranſgreſſions, he was bruiſed for our iniquities, the chaſtiſement of our peace was upon him, and with his ſtripes we are healed*, ſays the Prophet. *For ye know the grace of our Lord Jeſus Chriſt, that though he was rich, yet for your ſakes he became poor, that ye through his poverty might be made rich*, ſays the Apoſtle. Men having diſpleaſed God, and conſequently forfeited all right and natural poſſibility to happineſs; even whilſt they compleated the forlornneſs of their condition, by the lethargy of not being ſenſible of it, and were as careleſs to ſeek means of recovery, as they had been unable to deviſe them of themſelves; even then, his reſtleſs love would never be at quiet, till it had ſet his omniſcience on work, to contrive expedients, and find out a way to reconcile his juſtice and his mercy, in reconciling ſinners to himſelf. And this merciful deſign, by the incarnation of his Son, he proſecuted in a way ſo worthy of himſelf, and ſo advantageous to us, that our juſt wonder at it may keep us from having any, to find that, as St. *Peter* informs us, the very angels (prompted, queſtionleſs, by a religious curioſity) ardently deſire to look into thoſe divine myſteries. I find it hotly diſputed amongſt divines, (not only betwixt the Socinians and the Orthodox, but betwixt Orthodox and Orthodox) whether or no God could, without violating his juſtice, have deviſed any other courſe for the expiation of ſin, than the paſſion and death of Chriſt. But, without venturing to determine, whether or no God could, to redeem us, have choſen any other way; we may ſafely think, that he has choſen the moſt obliging and moſt endearing way; diſplaying in this divine manner of reſcuing us the ſevereſt juſtice, and the higheſt mercy; the greateſt hatred of ſin, and the greateſt love to Sinners; ſince by thoſe unequalled and unvaluable ſufferings, to which he delivered up, for us, that Son, who is near unto him, that he truly ſaid, *I and the Father are one*, he at once manifeſted, both how much he hated ſin, which he ſo heavily puniſhed in the perſon he moſt loved; (though that ſurety but adopted it, to free men from the inſupportable vengeance of it) and how much he loved ſinners, by giving up what he ſo loved, for a ranſom of thoſe that were guilty of what he ſo hated. And therefore our Saviour, though he did ſuch great things to ſatisfy the unbelieving and contumacious Jews of his being their promiſed Meſſiah, would not decline death to convince them; and, though he had not ſeldom done ſo much to make himſelf the object of their faith, would not be invited from the croſs, though the chief prieſts and ſcribes themſelves ſaid at his crucifixion, *Let him now come down from the croſs, and we will believe on him*. And Chriſt, to convince the world of their unableneſs to emerge and recover out of that deep abyſs, wherein the load of ſin (which, in ſcripture, is called *a weight*) had precipitated fallen man, came not into the world, until well nigh 4000 years of ſickneſs had made the diſeaſe deſparate, and the cure almoſt hopeleſs. So inveterate an obſtinacy at once widening the diſtance betwixt God and man, and proclaiming the latter's diſability to find, by his own wiſdom, expedients of reunion. Thus Chriſt healed and diſpoſſeſſed a dumb perſon, who was able to make intreaties but by the diſability of pronouncing them; and might truly ſay to the ſecure world, *I am found of them, that ſought me not*. And when our Saviour was come into the wretched world, of all the numerous miracles recorded in the goſpel, he ſcarce did any for his own private relief. And to ſhew, that as he endured his ſorrows for our ſakes, that *by his ſtripes we might be healed*; ſo were the joys he taſted in relation to us. We read not, (which is highly obſervable) in the whole goſpel, that ever he rejoiced but

Hoſ. xiv. 4.
Rom. v. 10.
Rom. v.
John iii. 16.
Phil. ii. 6, 7, 8.
Iſai. liii. 5.
2 Cor. viii. 9.
1 Pet. i. 12.
John x. 30.
Mat. xxiii. 7.
Heb. xii. 1.
Mat. ix. 32.
Iſai. lxv. 1.
Iſai. liii. 5.

once;

once; and that was, when his returned disciples informed him, that they had victoriously
Luke x. *chaſed devils* and *diſeaſes* out of *oppreſſed mortals*, and that by his *authority* men had been *diſpoſſeſſed* of both the tempter and puniſhment of ſin. He converſed among his contemporaries with virtues, as well atteſting what he was, as prophecies and miracles could do; and to teach man, how much he valued him above thoſe creatures, that man makes his idols, he often altered and ſuſpended the courſe of nature for man's inſtruction, or his relief, and reverſed the laws eſtabliſhed in the univerſe, to engage
Mat. xii. 24. men to obey thoſe of God, by doing miracles ſo numerous and great, that the Jews unbelief may be almoſt counted one. Yet were thoſe
Mat. iii. 12. wonders wrought for a generation, that aſcribed them to the devil, and returned them with ſo unexemplified an ingratitude, that it is not the leaſt of his wonders, that he would vouchſafe to work any of them for ſuch blaſphemous wretches; who were indeed, as ſome of the later Jews have too truely ſtyled themſelves, in relation to their fathers, *Chometz ben ya-yin*, vinegar the child of wine, a moſt degenerate offspring of holy progenitors. He ſuffered ſo much for them, that made him do ſo, that he ſuffered the addition of miſery of being thought
Iſai. liii. 12. to ſuffer deſervedly; *And he was numbred with the tranſgreſſors.* And though he lived as much a miracle as any he did, yet did his condition ſometimes appear ſo deſpicable and forlorn, that men could not know his deity but by his goodneſs, which was too infinite not to belong incommunicably to God. And though it were
John xv. 13. once a ſaying of our Saviour's, *Greater love hath no man than this, that a man lay down his life for his friends*; yet is not what is ſaid of the love here mentioned, to be underſtood of love indefinitely, or generally conſidered, but only of the ſingle acts or expreſſions of a man's love to his friends compared betwixt themſelves. And ſo the alledged paſſage ſeems to mean but this, that among the ſingle acts of kindneſs to a man's friends, there is not any one more highly expreſſive of a real and ſincere love, than to part with one's life for their ſakes. This text therefore would not be indefinitely applied to the affection of love itſelf, as if it could not poſſibly be greater than is requiſite to make a man content or willing to die for his friends; for he, that ſacrifices, beſides his life, his fortune alſo, his children, and his reputation, does thereby expreſs more love to them, than he could do by parting with his life only for them. And he that is forward to die for thoſe, that hate him, or, at leaſt, know him not, diſcloſes a more plentiful and exuberant ſtock of love, than he that does the ſame kindneſs but for thoſe that love him. And thus our Saviour would be underſtood, unleſs we would ſay, that he out-practiſed what he taught; for, he came to lay down his life even for his enemies, and (like the kind balſam-tree, whoſe healing wounds weep ſovereign balm to cure thoſe that made them) he refuſed not to die for thoſe that killed him, and ſhed his blood for ſome of thoſe that ſpilt it. And ſo little was his injured love to the ungrateful world diſcouraged or impaired by the ſavage entertainment he met with in it, that, after he had ſuffered from wretched men (for whoſe ſakes he left heaven to become capable of ſuffering) ſuch barbarous indignities, as might have made bare puniſhments appear mercy, and even cruelty itſelf ſeem no more than juſtice; when, I ſay, to hope for ſo much as his pardon were preſumption, he was pleaſed to create confidence of no leſs than his love, a virtue. Nor think it, *Lindamor*, impertinent to our preſent theme, that I inſiſt ſo much on what Chriſt has done and ſuffered for us, ſince both he himſelf informs us, that *he and his Father are one*; and ſome of the texts already mentioned have taught us, that it was an effect of God's love alſo to the world, that *he gave his only begotten Son to redeem it*; and, that *God commendeth his love towards us, in that while we were yet ſinners Chriſt died for us.* Wherefore I ſhall, without ſcruple, proceed to obſerve to you, that ſo free is Chriſt's dilection, that the grand condition of our felicity is our belief, that he is diſpoſed to make us happy, on terms, not only ſo honourable to him, but ſo advantageous to us, that, I was about to ſay, that poſſibly faith itſelf would ſcarce be exacted as requiſite to our happineſs, but that the condition does increaſe the benefit, by vouchſafing us bold and early anticipatious of it: For, *faith* being (as the Apoſtle terms it) *the ſubſtance of things hoped for, and evidence* (or conviction) *of things not ſeen*, wafts our joys to this ſide of the grave, bows heaven down to us, till our freed ſpirits can ſoar up to heaven; and does us ſuch a ſervice, as the Jewiſh ſpies did to their country-men, by bringing them over to this ſide *Jordan* into the wilderneſs, ſome of the pleaſant and delicious fruits of the bleſſed Land of Promiſe. I ſaid, *Lindamor*, that faith was the grand condition required in God's free grant of eternal life. Not that I would aſcribe any thing to a lazy, ſpeculative, and barren faith, in oppoſition to that lively and active one, which is called by the Apoſtle, πίστις δι' ἀγάπης ἐνεργουμένη, *faith operating by love*; ſince I am informed by St. *James*, that the divorce of faith and works is as deſtructive to religion, as that of ſoul and body is to life: but that I was willing to mind you, that though true faith (which cries like *Rachel, give me children or elſe I die*) be ever the pregnant mother of good works, yet are not thoſe works the cauſe, but the effects and ſigns of God's firſt love to men, (however afterward the children may nurſe their parents.) As, though the needle's pointing at the poles be, by being an effect, an argument of its having been invigorated by the loadſtone, or received influence from ſome other magnetick body; yet is not that reſpect unto the north the cauſe, but the operation of the iron's being drawn by the attractive mineral, *thou art good, and doſt good*, ſays the Pſalmiſt to his Maker. The greatneſs of his goodneſs is that, which makes it ours; nor doth he do us good, becauſe that we are good, but becauſe he is liberally ſo; as the ſun ſhines on dunghills, not out of any invitation his beams find there, but becauſe it is his nature to be

John x. 30. *See alſo* John lxxxiv. *ver.* 9, 10, 11. John iii. 16. Rom. v. 8. Heb. xi. 1. Numb. xiii. 23, 27. Gal. v. 6. Jam. ii. 26. Gen. xxx. Pſal. cxix. 68.

diffuſive

diffuſive of his light; yet with this difference, that whereas the ſun's bounty, by being rather an advantage to us than a favour, deſerves our joy, and not our thanks; becauſe his viſits are made deſignleſly, and without any particular intention of addreſs, (by ſuch a bare neceſſity of nature, as that which makes ſprings flow out into ſtreams, when their beds are too narrow to contain the renewed water that doth inceſſantly ſwell the exuberant ſources;) God, on the contrary, for being neceſſarily kind, is not leſs freely or obligingly ſo, to you, or me. For, though ſome kind of communicativeneſs be eſſential to his goodneſs, yet his extenſion of it without himſelf, and his vouchſafing it to this or that particular perſon, are purely arbitrary. To omit his love to the numberleſs elect angels; the ſtrict relations betwixt the perſons of the bleſſed Trinity, ſupplying God with internal objects, which imployed his kindneſs before the creation, and himſelf being able to allow his goodneſs the extent of infinity for its diffuſion. But (having glanced at this only by the by) we may yet further admiringly obſerve, that whereas men uſually give freelieſt where they have not given before, and make it both the motive and excuſe of their deſiſtance from giving any more, that they have given already; God's bounty hath a very different method: for he uſes to give, becauſe he hath given, and that he may give. Conſonantly to which, when the revolting Iſraelites had broken the contents, whilſt *Moſes* was bringing them the tables of the Law, and had thereby provoked the incenſed giver of it to the thoughts of a ſudden extirpation of ſo ingrateful and rebellious a people; we may obſerve, that, whereas God, as unwilling to remember his former goodneſs to them, ſpeaking to *Moſes*, calls them, *Thy people which thou broughteſt out of the land of Egypt*: *Moſes*, on the other ſide, to engage God to the new mercy of a pardon, repreſents to God his former mercy to them, and calls them *God's people*, which *he brought forth out of the land of Egypt, with great power, and with a mighty hand.* And ſo conſpicuous in the eternal Son was this property of the merciful Father, that when ſick *Lazarus*'s ſiſters implored his reſcue for their aſpiring brother, the motive they employed, and which proſpered their addreſſes, was, *Lord, behold* (not, he who loveth thee, but) *he whom thou loveſt is ſick.* And as he takes the firſt inducements of his bounty from himſelf; ſo do his former favours both invite and give rates to his ſucceeding bleſſings. And there is reaſon for it; for his pure love being all the merit, by which man can pretend to the effects of his bounty, it is but juſt, that the degree of his love ſhould proportion thoſe favours, which it is our only title to; and that God's liberality ſhould as well afford meaſures as motives to itſelf.

Exod. xxxii. 7.

Verſe 11.

John xi. 3.

Sect. 14. NOR is God's love leſs diſintereſted than free. His grand deſign upon us is but to make us inſtruments and partakers of his glory, and to bring us to everlaſting happineſs, by a way, that does as well elevate and dignify our nature, as the condition reſerved for us will. His method of ſaving us, if but complied with, does here, as the Apoſtle ſpeaks, *fit us for the inheritance of the Saints in light*; we being made (as St. *Peter* ſpeaks) *partakers of the divine nature, having eſcaped the corruption that is in the world through luſt.* So that thoſe things, wherein the nobleſt of the philoſophers placed their felicity, ſerve but to qualify and prepare Chriſtians for that higher bleſſedneſs, that is reſerved by God for thoſe that love him; and cannot but be heightened and endeared by the value, which graces and virtues had given men on earth, for ſuch a noble and rational kind of happineſs, as is apportioned to them in heaven. What ends can he have upon us, whoſe goodneſs and his bleſſedneſs are both infinite? He was inconceivably happy (in his own ſelf-ſufficiency) before the creatures had a being; and ſure that felicity, that needed not themſelves to be ſupreme, needs nothing that they can do *. Nor was it his indigence, that forced him to make the world, thereby to make new acquiſitions; but his goodneſs, that preſſed him to manifeſt, and to impart his glory, and the goods, which he ſo overflowingly abounds with. Witneſs his ſuſpenſion of the world's creation, which certainly had had an earlier date, were the Deity capable of want, and the creatures of ſupplying it. St. *Paul*, in his epiſtle to *Timothy*, ſtyles God Μακάριος, which we tranſlate *the bleſſed God*, but may, perhaps, more properly be rendered *the happy God:* and elſewhere, in the ſame epiſtle, he truly calls him *the happy*, as well as *only potentate. God* (ſays the Apoſtle) *that made the world, and all things therein, ſeeing that he is Lord of heaven and earth, dwelleth not*, &c. *As though he needed any thing, ſeeing that he giveth to all life, and breath, and all things.* And, *in him we live, and move, and have our being.* And indeed ſo coherent in the mind of a meer man, that does but conſider and underſtand the import of his own notions, is the belief of God's happineſs to that of his being, that I remember the Epicurean, *Lucretius* himſelf, even in that impious paſſage, where he denies divine providence, and in a ſeeming, but injurious complement, would, under the pretence of eaſing God of it, deprive him of the government of the world, does yet confeſs, that the divine nature muſt neceſſarily enjoy a ſupreme and endleſs tranquility; adding (to bring this to our preſent purpoſe) that it is

1 Tim. i. 11. 1 Tim. vi. 15. Act. xxvii. 24, 25, 26.

——*Privata dolore omni, privata periclis,*
Ipſa ſuis pollens opibus, nihil indiga noſtri.

Whereby he acknowledges,

'That from all griefs and dangers of them freed
'Rich in itſelf, it has of us no need.

Or, if you will have him ſpeak of the gods in the plural, like a heathen poet, that

'Far

* —— *Quid enim immortalibus atque beatis,*
Gratia noſtra queat largirier emolumenti,
Ut noſtrâ quidquam cauſâ gerere aggrederentur?
Lucret. ex Epic.

'Far above griefs and dangers, thoſe bleſt powers,
'Rich in their native goods, need none of ours.

A MUCH nobler poet tells us, that *the earth is the Lord's, and the fulneſs thereof, the world, and they that dwell therein.* Agreeably whereunto, that *great God, that formed all things,* (as in our tranſlation the ſcripture calls him) ſays in one of the Pſalms, *If I were hungry, I would not tell thee, for the world is mine, and the fulneſs thereof.* His ubiquity excludes all wiſhes of remove, by making his eſſence incapable of excluſion; for, whither ſhould he deſire to tranſport himſelf, that is every where, and can wiſh himſelf in no place, where he is not already? His ſufficiency is ſuch, that he can ſee no goods, but what he gives or hath, (or rather both beſtows and poſſeſſes) his plenty being ſo unexhauſted a ſpring of goods, that his liberality does leſs impoveriſh God, than the ſun's light does him, or imparted knowledge impairs the teacher's ſtock. And therefore, though St. *James* does very juſtly call God *the father of lights,* who is the beſtower of every good and every perfect gift; yet the *friend of God,* (as the ſcripture calls *Abraham*) and that royal prieſt, (whom the writer to the Hebrews teaches us to have been ſo illuſtrious a type of him, whom he calls *the high prieſt of our profeſſion*) do both of them, in the ſame chapter, ſtyle him, *The poſſeſſor of heaven and earth.* No, no, God needs not beg from, nor covet in the creatures ſhallow ſtreams, thoſe goods, of which he not only hath, but is the ſource. Our greateſt ſervices to our Creator muſt be to diſcharge our ſelves, not to advantage him, nor as thinking to add any thing to a felicity, which were not infinite, could it admit increaſe. Our higheſt performances, though they be dues, amount not unto tributes, but are rather like thoſe pepper-corns of rent, which freeholders pay, not with hope or with intent to enrich their landlord, but to acknowledge, that they hold all from him. When we admire the ſun, our ſeeing of his light doth not increaſe it; it makes it not greater, but only makes it ours; and when we turn away, or ſhut our eyes, that glorious planet ſuffers no eclipſe, and is not at all darkened or impaired, nor doth he thereby loſe his light, but we: the eaſineſs of the application requires, and excuſes its omiſſion. *If thou ſinneſt,* (ſays *Elihu* in *Job*) *what doſt thou againſt him? if thou be righteous, what giveſt thou him? or what receiveth he of thine hand? thy wickedneſs may hurt a man, as thou art, and Thy righteouſneſs may profit the ſon of man.* In effect, the wicked's ſpite againſt God is but like a madman's running his head againſt the wall, that leaves the wall unſhaken, but daſhes his own brains out. God inhabits a felicity (as well as light) inacceſſible to all inferiour attempts: his ſovereign tranquillity is ſo ſublimely placed, that it is above the reach of all diſquieting impreſſions; and, like the ſtars, that feel not the diſeaſes their inauſpicious influence produces, he doth not reſent the torments he inflicts. God's juſtice is not leſs eſſential to him than his mercy; witneſs that (the numbers of the ſaints and the reprobate conſidered) thouſands fall ſacrifices to the ſeverer attribute, for one that proves capable of the milder. He ſaid, *He would get himſelf honour upon* Pharaoh *and all his hoſt,* when he deſigned their ruin in the *Red Sea:* and *Moſes* ſaid, *he hath triumphed gloriouſly* in effecting it. And in *Ezekiel* he ſays, *Behold I am againſt thee, O* Sidon, *and I will be glorified in the midſt of thee, and they ſhall know, that I am the Lord, when I ſhall have executed my judgments in her, and ſhall be ſanctified in her.* Thus, when a flaſh of God's indignation (kindled by that ſtrange fire they preſumed to offer before him) had blaſted the two preſumptuous ſons of *Aaron,* God is ſaid *to have been ſanctified in them that come nigh him, and to have been glorified before all the people*; ſuch eminent and exemplary inſtances of ſeverity manifeſting him to be ſo holy in his laws, and ſo concerned for them, that even the miniſters of his altars ſhall not violate them with impunity, but find him (what the writer to the *Hebrews* calls him) *a conſuming fire*; who will be glorified before all his people, either by the obedience of thoſe that approach him, or by their deſtruction. So to evidence, that God can derive ſatisfaction as well from the exerciſe of provoked juſtice, as from that of his provoked mercy, the ſacred orator uſes this remarkable *antanaclaſis: And it ſhall come to paſs, that as the Lord rejoiced over you to do you good, and multiply you; ſo will the Lord rejoice over you to deſtroy you, and bring you to naught.* Thus, though it be truly ſaid of God by the prophet *Jeremiah,* that *he doth not afflict willingly, nor grieve the children of men*; (and therefore the determined conſumption of the whole land, which our bibles Engliſh, *God's work his ſtrange work,* other tranſlators read, *Opus alienum ſuum:*) yet when the ſins of incorrigible offenders are grown to that provoking height, that his mercy intercedes no more to avert or ſuſpend the inflictions of his juſtice, than how much he can ſatisfy himſelf in deſtroying thoſe, that would not be preſerved, may be gueſſed at by that formidable expreſſion in *Ezekiel*; where, having foretold, what havock the ſword, the famine, and the peſtilence ſhould make amongſt the intractable and diſperſed Iſraelites, he adds, (as a kind of Επινίκιον) *thus ſhall mine anger be accompliſhed, and I will cauſe my fury to reſt upon them, and I will be comforted.* The howlings of the damned as well ſound forth his praiſes, as do the hallelujahs of the ſaints; they both do ſing to him an everlaſting canticle of praiſe: only in this great concert of his whole intelligent creation, the deſignleſly conſpiring voices are as differing as the conditions of the reſpective ſingers. Hell's darkneſs doth as well contribute to God's glory, as heaven's eternal ſplendor; as ſhadows, judiciouſly placed, do no leſs praiſe the painter, than do the livelier and brighter colours. And as when the earth doth ſend black, noiſome, and ſulphureous exhalations up toward the ſky, alas, they reach not heaven, nor diſcompoſe the ſpheres; but all the ſtorms and thunders they produce fall on that globe they came from, and there do

Pſal. xxiv. 1. Prov. xxvi. 10. Pſal. l. 12. Jam. i. 17. Jam. ii. 23. Heb. vii. *per totum.* Heb. iii. 1. Gen. xiv. 18, 22. Job xxxv. 6, 7, 8. 1 Tim. vi. 16. Exod. xiv. 17, 18. Exod. xv. 1. Ezek. xxviii. 22. Levit. x. 3. Heb. xii. 29. Deut. xxviii. 63. Lam. iii. 33. Iſa. xxviii. 21. Ezek. xiii. 5.

all their miſchief: ſo, the wicked may wrong God indeed, yet do they really harm but themſelves by all their greateſt ſins, which trouble him chiefly, but becauſe they neceſſitate him to puniſh them; for the tranſgreſſions, that do moſt provoke God, do him not the leaſt harm. An impious perſon may (as *Elihu* lately informed us) hurt a man as himſelf is, not that ſupremely bleſſed Deity; the reſult of whoſe infinite perfections is a reſembling happineſs, which is as inſeparable from him as his eſſence. Our offences may derogate from his acceſſional glory, not from his eſſential felicity; or rather, the moſt deſperate ſinners, by their greateſt crimes, can but change the attribute they ſhould bring honour to, and but oppoſe the glorifying of his goodneſs to occaſion the glorifying of his juſtice; ſince he will be infallibly glorified, ſoon or late, either by men's actions, or their ſufferings; by their practice of duties, or puniſhment for ſin. Thus you ſee, how little God is beholden to you for your declining hell; nor will the ſcore be very much encreaſed by your addreſſes and attempts for heaven. *Can a man* (ſays *Eliphaz*) *be profitable unto God, as he that is wiſe may be profitable unto himſelf? Is it any pleaſure to the Almighty, that thou art righteous? or is it gain unto him, that thou makeſt thy ways perfect?* Congruouſly to which ſenſe the Pſalmiſt ſays, *my goodneſs extendeth not to thee.* The fire, that we kindle on God's altars, heats and enlightens us, but warms not heaven at ſo diſtant a remove, nor is wanted in the ſun's reſidence. We have all the redolence of the perfumes and incenſe we burn upon his altars; the ſmoke doth vaniſh ere it can reach the ſky, and whilſt it is undiſperſed, but clouds and but obſcures it. Alas, our beſt performances are as uſeleſs ſervices to God, as the heir's bringing wax to his departing father is to him; which adds not any thing to the rich man's ſtore, and is by him deſired and accepted, only to ſeal away a fortune to his ſon. Though therefore it be true, that God is pleaſed with our performances, yet is that welcome he vouchſafes to give them ſo far from enabling us by them to requite his love, that it increaſes the unrequitedneſs of it; ſince he is delighted with them, as they afford him juſt riſes to reward them. How far from mercenary is then God's bounty! ſince he accepts our acknowledgements of his former bleſſings, (chiefly) to make them opportunities of conferring freſh ones; as good old *Iſaac* deſired his ſon's veniſon, that from the reliſhing of that ſavory meat he might take an opportunity to bleſs him.

Job xxii. 2, 3.

Pſal. xvi. 2.

Gen. xxvii. 4.

And the better to diſcover, how diſintereſted God's favours are, let us further conſider, how little they are requitable; for we can give him nothing but his own, (nor, heaven knows, all that neither:) and both the will and power to ſerve him are his, upon ſo juſt and many ſcores, that we are unable to retribute, unleſs we do reſtore; and all the duties we can pay our maker are leſs properly requitals than reſtitutions. When *David* and his officers had offered towards the ſtructure of that magnificent temple, which they ſeemed ambitious to make a manſion inferiour to heaven only; the king himſelf gave three thouſand talents of gold, and ſeven of refined ſilver; and the heads of the people five thouſand talents (beſides ten thouſand drachms) of gold, ten thouſand talents of ſilver, eighteen thouſand of braſs, and a hundred thouſand of iron, (a treaſure, of which I ſcarce remember to have read the like in any hiſtory) beſides a number of all manner of precious ſtones, capable of impoveriſhing the very *Indies*. They perfumed this noble and unequalled offering with a ſolemn confeſſion, which perhaps in God's eſteem was much more precious than it: *Thine, O Lord,* (ſays the royal prophet in the name of all) *is the greatneſs, and the power, and the glory, and the victory, and the majeſty; for all that is in heaven and in earth is thine. Thine is the kingdom, O Lord, and thou art exalted as head above all. Both riches and honour come of thee, and thou reigneſt over all. And in thine hand is power and might; and in thine hand it is to make great, and to give ſtrength unto all. Now therefore, our God, we thank thee, and praiſe thy glorious name. But who am I? and what is my people, that we ſhould be able to offer ſo willingly after this ſort? for all things come of thee, and of thine own have we given thee. For we are ſtrangers before thee, and ſojourners, as were all our fathers. Our days on earth are as a ſhadow, and there is none abiding. O Lord our God, all this ſtore, that we have prepared to build thee an houſe, for thy holy name, cometh of thine hand, and is all thine own. Who,* (ſays the Apoſtle, in a queſtion that imports its own negative) *hath firſt given to him, and it ſhall be recompenſed to him again? for of him, and through him, and to him, are all things.* Nay, even our love it ſelf (that poor man's ſurety and exchequer, that doth pay all his debts by ſupplying him with the prerogative to coin his deſires and wiſhes of an arbitrary value) is here unable to diſcharge our debts; our love being too much the effect, to be capable of being the recompenſe of God's. And ſurely, the divine amoriſts had cauſe to ſay, that *herein is love, not that we loved God, but that he loved us.* And, as the ſame Apoſtle elſewhere ſpeaks, *we love him, becauſe he firſt loved us.* If, in effect, we look upon the unworthy conteſt betwixt God's mercies and moſt men's ingratitude, and but reflect upon the ſmall return of love that the greateſt diſburſements of his do uſually bring home; we cannot but acknowledge, (as *David* in the lately mentioned ſcripture did) that our loving God for his favours, is one of the greateſt favours that we love him for. So unrequitable is God's love, and ſo inſolvent are we, that that love vaſtly improves the benefit, by which alone we might have pretended to ſome ability of retribution; and ſo unlimited is this impotence of ours to recompenſe or repay God's dilection, that it extends to, and fetters our very wiſhes. For God enjoys an affluence of felicity, ſo perfect and entire, that even our wiſhes can aim at nothing for him worthy of him, unleſs inſtructed by what he already actually poſſeſſes; and the ſenſe of this ſame very impotence, to ſome of the greateſt proficients

1 Chron. xxix. 11, 16.

Rom. xi. 35, 36.

1 John iv. 10.

1 John iv. 19.

in

in *Seraphick Love*, appears not the leaſt uneaſy property of it. It grieves us ſenſibly, to ſee our ſelves reduced to be only paſſive, and the receivers in this commerce. We would fain contribute ſomething, and cannot always refrain from devoting our wiſhes to increaſe his happineſs, to whom we owe all ours. And ſome holy perſons (particularly St. *Auſtin*) have, by the exuberance of their gratitude and devotion, been tranſported to make wiſhes, and uſe expreſſions, wherein their affections had a greater ſhare than their reaſon, and which argued them much better to apprehend, how much God deſerved of them, than how little he needed them. But, upon ſecond thoughts, we ſhall find, that the cauſe of our grief ought to turn it into our joy, ſince the deſires we would frame, aiming at God's being infinitely happy, are all fulfilled before they are conceived, and that in the moſt advantageous and nobleſt way; for could God's happineſs admit acceſſion by our accompliſhed wiſhes, there were then a poſſibility of his wanting ſomething to render it compleat. And ſure, it is a more ſupreme felicity to be by nature tranſcendently above all increaſe of bleſſedneſs, than to receive the greateſt, that men can wiſh.

Sect. 16. To proceed now to the conſtancy of God's love; we cannot entertain of God any apprehenſions, not altogether unworthy of him, and criminally injurious to him, without believing, that to think, that he can be inconſtant, is as great a crime as it were a miſery to find him ſo. His love is like his eſſence, immutably eternal, reaching from everlaſting to everlaſting; it preceded the nativity of time, and will ſurvive its utmoſt period and obſequies. *Having loved his own, which were in the world, he loved them unto the end*, ſays the Evangeliſt: and when St. *James* had told us, that *every good gift and every perfect gift is from above, and cometh down from the father of lights*, he adds, (to complete our conſolation) *with whom is no variableneſs, neither ſhadow of turning. Of his own will begat he us of the word of truth.* And in effect, ſince God takes the motives of his love to us from himſelf, not from us, the unchangeableneſs of his nature ſeems ſtrongly to infer that of his charity, and our happineſs in it. For, *I am the Lord, I change not; therefore ye ſons of Jacob are not conſumed*, ſays God by the laſt of his prophets: and in *Jeremiah* he tells his people, *I have loved thee with an everlaſting love.* And what God once ſaid to the generous *Joſhuah*, *I will never leave thee nor forſake thee*, is by the writer to the Hebrews applied to believers in general; for *the gifts and calling of God* (ſays the ſame author elſewhere) *are without repentance.* Nor do thoſe croſſes, that ſeem due to his anger, deſtroy the immutability of his love, ſince even that anger is an effect of it, proceeding from a fatherly impatience of ſeeing a ſpot unwiped off, in the face he loves too well to ſee a blemiſh in it; and from his deſire to ſee his child an object fit for a larger meaſure of his kindneſs: as when we beat the duſt out of a ſuit we fancy, we ſtrike not out of anger, but only to remove that, which doth ſully it, and hinder us to take that delight in it, which our fondneſs would be pleaſed with a juſt cauſe to find. *As many as I love, I rebuke and chaſten*, (ſays our Saviour.) And, *I know, O Lord*, (ſays the Pſalmiſt) *that thy judgments are right, and that thou in faithfulneſs haſt afflicted me*; the furnace of affliction being meant but to refine us from our earthly droſſineſs, and ſoften us for the impreſſion of God's own ſtamp and image. The great and merciful architect of his church, (whom not only the philoſophers have ſtyled, but the ſcripture itſelf calls τεχνίτης, an artiſt or artificer) employs not on us the hammer and the chizzel, with an intent to wound or mangle us, but only to ſquare and faſhion our hard and ſtubborn hearts into ſuch *living ſtones*, as may both grace and ſtrengthen his heavenly ſtructure. Nor is God only thus conſtant to his love, but to his lovelineſs. Our female beauties are uſually as fickle in their faces as their minds, and more certainly in the former; becauſe, though caſualties ſhould ſpare them, age brings in a neceſſity of a change, nay, a decay; leaving our doaters upon red and white inceſſantly perplexed, by the incertainty both of the continuance of their miſtreſs's kindneſs, and of the laſting of her beauty, (both which are neceſſary to the amoriſt's joys and quiet): for, ſometimes, when the miſtreſs's humour doth not change ſo much, as to prove guilty of the fault of inconſtancy, her face alters enough to make her lovers wiſh inconſtancy no fault; or, that ſhe had committed it, that her fickleneſs might afford them the excuſe of imitation or revenge. But, in devotion, we are equally ſecure from both theſe dangers; ſince God doth not deſiſt from bleſſing us with his love, nor ceaſes ever from deſerving the height of ours. Nor is he only conſtant in making us the objects of his love, but alſo in bending and inclining us to make him the object of our ſtrongeſt affections; ſo that he not only perſiſts in continuing to us both the offer and value of his love, but perſeveres to give us a receptive diſpoſition to welcome it to us, and reflect it up to him. The want of ſuch a diſpoſition loſt *Adam* paradiſe, and the fallen angels heaven; there being to the object, that muſt ſecure our love, ſuch a nature requiſite in reference to our affections, as philoſophers are pleaſed to aſcribe to the world's centre in relation to heavy bodies, which, they teach us, that magnetick point has the double faculty, not only to draw thither, but to keep there. For ſo untoward and croſs-grained are we, in point of our own good, and ſo unfit to procure, and ready to deſert, our own felicity, that neither its excellency is a ſufficient motive to carry our addreſſes to it, nor its poſſeſſion a competent tie to intercept in us all deſigns of revolts and divorces: but we muſt be uſed as peeviſh children are, who, (on the one ſide) when their mouths are out of taſte, and they refuſe to take what is neceſſary for them, muſt have it not only offered them, but forced upon them, and be (as it were) made to receive it; and who (on the other ſide) muſt be reſtrained from gadding, when the beauty of the manſions they live in cannot invite their ſtay; but they

John xxxi. 1. Jam. i. 17. Mal. iii. 6. Joſh. i. 5. Heb. xiii. 5. Rom. xi. 29. Rev. iii. 19. Pſal. cxix. 75. Heb. xi. 10. 1 Pet. ii. 5.

they would gladly leave the proudeſt palaces architecture can boaſt, to run into the ſtreet, and dabble in the kennel. All theſe three properties of divine conſtancy are not ill ſhadowed in the operations of the load-ſtone, (a mineral, in which I have made too many experiments, not to be by you allowed to make ſome compariſons to it.) For, firſt, it never forſakes its inclinations for the ſteel; next, being united to it, it retains ſo conſtantly its attractive qualities, that it gives not the needle any motive of deſerting it; and thirdly, it doth never rightly touch the amorous ſteel, without leaving an impreſſion, which ever after diſpoſes it to a converſion to that magnetick poſture, which beſt fits it to receive freſh influences. To which let me add this other reſemblance betwixt God's work on us, and the load-ſtone's on the iron, that the kind ſtone attracts a needle to it, not to advantage itſelf by that union, but to impart its virtue to what it draws. Beſides, abſence and rivals, thoſe frequent ruiners of other lovers happineſs, can threaten nothing of formidable to yours. For, abſence (which ſo divorces us from that, which animates us, that lovers do not ſo improperly ſtyle it death, if death be but the ſeparation of ſoul and body) by God's ubiquity we are ſecured from; he is ever preſent with us, or rather in us. You, that, not long ſince, ſo highly valued the opportunities of converſing with your miſtreſs for ſome few moments, ſhall here find your privileges improved to a permiſſion; nay, an invitation, of entertaining the object of your love at all times; no hour renders your viſits unſeaſonable, nor no length tedious: he is rather welcomeſt to God, that comes to him oftneſt, and ſtays with him longeſt. What favours were vouchſafed to that antient propheteſs, (who was likewiſe one of the firſt evangeliſts) who for many years *departed not from the temple, but ſerved God with faſtings and prayers night and day*, the beginning of St. *Luke*'s goſpel may inform you. The midnight hymns of *Paul* and *Silas* did not only not diſturb or offend him they praiſed, but procured the viſit of an angel to bring them miraculous and unexpected liberty, as a proof of the acceptableneſs of their ſeemingly unſeaſonable devotions. When *Enoch had walked with God* as many years as the year has days, God was ſo far from being importuned or tired by that laſting aſſiduity, that vouchſafing him an unexampled exemption from death, he was pleaſed by a new and a nearer cut to heaven, to admit him to a yet cloſer, more immediate, and more undiſtracted communion with himſelf. And when *Moſes* had ſpent no leſs than *forty days and forty nights* in converſing (if I may uſe ſo familiar a term) with God in the mount, he brought down thence, inſtead of a penance for his importunity, ſo ſignal and radiant a teſtimony of God's peculiar favour, that his dazzled countrymen were as much diſabled, as invited, to gaze on an object of ſo much wonder. And then, how proud do we ſee many lovers of their ſufferings, when ſhe but knows of them, for whom they are endured? But in *Seraphick Love*, there is not the leaſt good wiſh, or privateſt ſuffering, nay, not a whiſpering ſigh, or cloſer thought, that ſilently groans or aſpires in the amorous ſoul, but he both ſees and hears, that puts his ſervants *tears into his bottle*, ſweetening and recompenſing the greateſt misfortunes, that his love occaſions, with ſuch ſupport and joys, as hinder us to feel them, and make them deſerve a contrary name. Each amorous ſoul may ſay to God with *David*, *Thou knoweſt my down-ſitting, and my up-riſing; thou underſtandeſt my thoughts afar off; thou compaſſeſt my path, and my lying down, and art acquainted with all my ways.* And Chriſt alſo himſelf has ſo attentive an eye upon the amorous ſoul, that he is held forth in the Apocalypſe, as telling the ruler of the church of *Smyrna*, *I know thy works, and tribulation, and poverty*; and ſaying to the angel of the church of *Pergamus*, *I know thy works, and where thou dwelleſt, even where Satan's ſeat is; and thou holdeſt faſt my name, and haſt not denied my faith, even in thoſe days, wherein Antipas was my faithful martyr, who was ſlain among you, where Satan dwelleth.* So that no endearing circumſtance of our love eſcapes unobſerved by him, who has done and ſuffered ſo much to engage us to it. God remembers not our endeavours to ſerve him the leſs, for our having forgotten them: *When ſaw we thee any way diſtreſſed, and relieved thee?* will be the queſtion of thoſe, to whom heaven it ſelf will be at the laſt day awarded, as having miniſtered to their Redeemer. Thoſe, that in degenerate times, ſuch as ours, *Lindamor*, did, like *Lot* in *Sodom*, mourn for their ſins, that mourned not for their own, and condoled among themſelves the ſpreading wickedneſs of the times they lived in; though probably the dangers threatened them by the very ſinfulneſs they deplored made them affect ſuch privacies in their conferences, as freed them from the thoughts of being over-heard; yet the ſcripture informs us, (and it is a comfortable as well as memorable paſſage) that *the Lord hearkened and heard it, and a book of remembrance was written before him, for them, that feared the Lord, and that thought upon his name: then ſhall he return, and diſcern betwixt the righteous and the wicked, between him that ſerveth God, and him that ſerveth him not.* *I know*, ſays Chriſt, (not only to the angel of *Smyrna*, but to each true ſufferer for him) *thy works, and tribulation, and poverty: fear none of theſe things, that thou ſhalt ſuffer; be thou faithful unto death, and I will give thee a crown of life.* God is often pleaſed to accept thoſe good thoughts and intentions of his ſervants, which never arrive at actual performances. Though *David* built not the temple he deſigned, yet his ſon, that did it, informs us, that God ſaid unto him; *Foraſmuch as it was in thine heart to build an houſe for my name, thou didſt well in that it was in thine heart, &c.* And it is the epithet our Saviour gives God, *your Father which ſeeth in ſecret, &c.* Nor need we fear our rivals ſhould ſupplant us, ſince we can have none in devotion, whoſe prayer and endeavour it is not, that God would love us more. For his love to you being (as the chiefeſt merit) the ſtrongeſt motive

Luke ii. 37, &c.

Act. vi. 25, 26, &c.

Gen. v. 22, 23, 24.

Exod. xxxiv. 30.

Pſal. lvi. 8.

Pſal. cxxxix. 2, 3.

Rev. ii. 8, 9.

Verſe 12, 13.

Mat. xxv. 37, &c.

Mal. iii. 16, 17.

Rev. ii. 9, 10.

2 Chron. vi. 8.

Mat. vi. 6.

tive

tive and title unto theirs, they cannot but wiſh him well, whom God doth love ſo; and cannot wiſh him better, than by imploring for him freſh additions, both of that love of God, and grateful diſpoſitions to return it. Our Saviour aſſures us, that *there is joy in the preſence of the angels of God over one ſinner that repenteth*. And the ſole hymn (except a viſionary one) I find recorded of the celeſtial choir, was ſung for a bleſſing to mankind, wherein (for aught I know) their love and ſympathy alone concerned them: *For unto us* (men) *the child is born, and unto us the Son is given, who took not upon him the nature of angels, but the ſeed of Abraham*. So noble and ſo diſintereſted doth divine love make ours, that there is nothing, beſides the object of that love, that we love more than our concurrents in it, perchance out of a gratitude to their aſſiſting us, to pay a debt (of love and praiſe) for which alas! we find our ſingle ſelves but too inſolvent.

Luke xv. 7, 10.
Luke ii. 13, 14.
Iſai. ix. 6.
Heb. ii. 16.

Sect. 17. PERHAPS I need not mind you, *Lindamor*, that divers paſſages of the foregoing diſcourſe ſuppoſe the truth of their doctrine, who aſcribe to God, in relation to every man, an eternal, unchangeable and inconditionate decree of election, or reprobation. Yet concerning the controverſies betwixt the Calviniſts and the Remonſtrants about predeſtination, and the coherent doctrines, it were improper to give you here my ſenſe. Thoſe, that are truly pious of either party, are perhaps otherwiſe looked on by God than by one another, as contending, which of God's attributes ſhould be moſt reſpected; the one ſeeming to affirm irreſpective decrees, to magnify his goodneſs; and the other to deny them, but to ſecure the credit of his juſtice. And even in honouring the ſame attribute, his goodneſs, theſe adverſaries ſeem rivals, the one party ſuppoſing it beſt celebrated by believing it ſo irreſiſtible, that to whomſoever it is intended, he cannot but be happy; and the other thinking it moſt extolled by being believed ſo univerſal, that it will make every man happy, if he pleaſes: the one party electing to honour free-grace, by aſſigning it (as to men) an unlimited vaſt extent; as the other does, by aſcribing it an infallibly victorious degree. But though my haſte, and the nature of my theme make me decline the controverſies about predeſtination; yet ſince the doctrine, that maintains it, is not only by almoſt all the reſt of mankind, but by the reſt of the proteſtant churches themſelves, (the Lutherans, and divers learned divines of the church of *England*) not only rejected, but deteſted as little leſs than blaſphemous, (as indeed they, that judge it an error, cannot but be tempted to think it a dangerous one, and of very pernicious conſequence, ſo far forth as its ſequels are permitted to have influence on men's practice) I think it not amiſs to adverti ſe you, that the doctrine of predeſtination is not neceſſary to juſtify the freeneſs and the greatneſs of God's love. For ſo conſpicuous and refulgent a truth is that of God's being the author of man's felicity, that the diſpute betwixt the Calviniſts and Arminians is not ſo much concerning the thing, as concerning the manner of its being proffered; the former affirming grace to be irreſiſtibly preſented; the latter, though they deny it to be irrejectable, yet granting, not only that it is altogether free and undeſerved, but alſo, that the proffer is made, both with a power enabling thoſe, to whom it is rendered, to accept it, and with ſuch engaging invitations, that man at his firſt converſion need contribute nothing to his felicity, but the not wilfully refuſing it, and may more properly be ſaid to owe it unto God, than the beggar to owe his alms to his reliever, though he opens his hand to receive it; which he might have declined to do, if he would have wilfully courted his own prejudice. Chriſt paid *a ranſom to redeem us*, it is true, and he is therefore called, *the Lord that bought us*: but it was God's free goodneſs, both to provide us that Chriſt, and to accept of that ranſom, neither of which he was obliged to do; and therefore the ſcripture aſcribes it not to the juſtice, but to the love of God to the world, that *he ſent his only begotten Son to redeem it*: and St. *Paul* in the ſame text tells us, both that *we are juſtified*, δωρεὰν τῇ αὐτοῦ χάριτι, *freely by his grace*, and yet that it is, διὰ τῆς ἀπολυτρώσεως, *through the redemption*, (purchaſed for a ranſom; the original word Engliſhed redemption relating to the price paid for the redeeming of captives) *that is in Jeſus Chriſt*. It is confeſſed on all hands, that merit muſt be diſclaimed, and thoſe that ſeem to expect ſomething from God as a due, acknowledge, that if his promiſe did not, their actions could not, make it ſo; and that it is to his mercy they owe the right they have to confide in his juſtice. St. *Paul*, who having *fought the good fight, finiſhed his courſe, and kept the faith*, expected *a crown of righteouſneſs from the Lord*, under the notion of the righteous judge; yet tells us, *that by grace we are ſaved, through faith, and that not of our ſelves, it is the gift of God*. Whoſe promiſes, now they are made us, allow us indeed to expect heaven from his juſtice; but *the making us thoſe great and precious promiſes*, (as St. *Peter* juſtly ſtyles them) muſt be acknowledged the pure effect of *his free and undeſerved goodneſs*; which to believe infinite, we need but conſider the diſproportion betwixt ſuch a recompenſe as eternal glory, and the leaſt imperfect performanſes of ours: which though they needed not pardon, could not at leaſt challenge any reward from him, who, as our Creator, has ſuch a right to exact of us what ſervices he pleaſes, without propoſing us any recompenſe, that our exacteſt obedience to all his commands would yet leave us to confeſs our ſelves *unprofitable ſervants, who have done but what it was our duty to do*; and what, if we had not done, we had given God, who had the power, the right and provocation to puniſh us. And indeed, ſo conſcious are men generally (if not naturally) to their being beholden to God for their felicity, that even thoſe, that miſtake or oppoſe his way of doing them good, will yet be ſure to find out ſome notion or other, under which they may conceive themſelves God's debtors for his bleſſings. That the more ſober ſort of Romiſh catholicks them-

John iii. 16.
Rom. iii. 24.
2 Tim. iv. 7, 8.
Eph. ii. 8.
2 Pet. i. 4.
Luke xvii. 10.

themſelves aſcribe not ſo much to merit, (properly ſo called) nor ſo little to God's grace, as the more quarrelſome writers of their party have given the more eager diſputants of ours occaſion to reproach them, were perhaps no difficult taſk to manifeſt, if my haſte would give me leave. That the Arminians own the freeneſs and unmeritedneſs of God's grace, the Remonſtrants * confeſſion and apology are very careful to ſatisfy the world. And even the Socinians, (how proſperouſly I determine not) are not a little, or uninduſtriouſly ſollicitous to free their erroneous doctrine of juſtification from the objected guilt of its tendency to draw the imbracers of it to *ſacrifice to their own nets*, and thank themſelves for their felicity. Which brings into my mind a paſſage, that I lately read in one of the chief modern upholders of that ſect, *Schlichtingius*; who is wont, in my opinion, where his ſubject will bear it, to diſcourſe as fairly and as rationally as almoſt any writer that I have met with of his perſuaſion; and who labours to reconcile *Socinus* his doctrine with the freeneſs of God's grace, by conſiderations, which, not to injure him, I ſhall preſent you with in his own words. *Ad retundendam vero* (ſays he, diſputing againſt the learned *Meiſnerus*) *arrogantiam juſtificatorum, & ne dicant ſe meruiſſe gratiam, non eſt neceſſe ſervum in homine arbitrium inducere; non debet virtus tolli, ut tollatur arrogantia. Sufficit,* 1. *Quod nec velle nec perficere poſſint, niſi Deus & voluntatem excitet, & vires augeat.* 2. *Quod ea, quæ divinis adjuti viribus faciunt, nullo modo dignitate & pretio divinæ gratiæ reſpondeat, ſed infinito intervallo ab ea abſint.* Nay, though the modern and degenerate Jews be, upon the ſcore of being the great patrons of man's free-will, not cauſeleſly eſteemed the great oppugners of God's free-grace; yet both from their famous Rabbi, and my learned acquaintance, *Manaſſeh Ben-Iſrael*, and from divers others of their moſt eminent writers, has the truth ſometimes extorted confeſſions, which, though made upon erroneous grounds, were not very far ſhort of orthodox. To which purpoſe I remember, that a Jewiſh profeſſor of Hebrew (who aſſiſted me in my ſtudies of that myſterious tongue) being, as the reſt of his nation, an eager and peremptory champion of free-will, conceived, that even that liberty, which to us ſeems leaſt to indebt men to their Creator, did tranſcendently oblige him unto God. For, one day that we were privately and freely diſcourſing together of matters of religion, he told me, he thought men owed more to God's goodneſs, than the very angels do. For, ſaid he, whereas God, without any good work of theirs, but purely out of his goodneſs, conferred on them that bleſt condition they enjoy, by giving man a free-will, by the good uſe of which he may glorify his Maker, when, by abuſing it, it is in his power to diſhonour him; he allows man that higheſt ſatisfaction and privilege, of co-operating to his own felicity.

Sect. 18. And now, *Lindamor*, we are arrived at the laſt property, which qualifies God the fitteſt object for our love, which is, the advantageouſneſs of his to us, both in the preſent and the future life. And firſt, even in this world we owe God no leſs than all the goods we poſſeſs. We owe him both what we have, and that we are: for we may ſay truly of God with the Pſalmiſt, *It is he that hath made us, and not we our ſelves.* And we were not only in his hands ſo like *clay in the potter*'s, that he might have made us any thing; but we were ſo purely that negative, from whence we were extracted, that he (if he had pleaſed) for ever might have left us to our firſt nothing. His love is the firſt original and fountain-bleſſing; all the reſt are but as pipes (and inſtruments) to convey, and ſerve but to hand it to us. Your wit wins you applauſe, your induſtry heaps you up treaſures; be it granted. But who gave you that wit? and did both give and proſper that boaſted induſtry? Certainly, God as much gives us all the goods we poſſeſs, as he that gives a beggar a thouſand pounds, gives him the clothes, and meat, and all the bravery it helps him to. But beſides theſe more obvious preſents of God's bounty, we enjoy other effects of his goodneſs, which, though by the cuſtomarineſs of their being poſſeſſed, they prove leſs conſpicuous than the other, yet grow no leſs prized, when the want or loſs of them makes us ſenſible of the true value of them. Had I the leiſure, *Lindamor*, to lead your thoughts with me to the galleys, and ſhew you there thoſe wretched captives, that are chained to the oars they tug at, and though expoſed to all the miſeries and hardſhips of a tempeſtuous ſea, have oftentimes cauſe given them, by their barbarous uſage aſhore, to fear the ocean leſs than any port, ſave death. Could I draw from you the curtains of ſick and dying men, and open to you that ſad ſcene, where ſome pine and languiſh by diſtempers, that deprive them of all joys, advantages, and (what is more conſiderable) uſes of life, before they eaſe them of life it ſelf; others breathe rather than live, perpetually tormented either with their diſeaſes or phyſick to protract a wretched life, upon terms that turn it into a trouble; and others ſtruggling with the rude pangs of death, are yet, perchance, leſs tormented by them, than by the ſad proſpect of their former life, and the remembrance of thoſe criminal pleaſures, *which yet it perhaps leſs troubles them that they muſt now forgo, than that they once enjoyed them.* Should I, *Lindamor*, bring you into hoſpitals, and ſhew you there the various ſhapes of human miſery, and how many ſouls, narrowly lodged, (if I may ſo ſpeak) in ſynecdochical bodies, ſee their earthen cottages moulder away to duſt; thoſe miſerable perſons by the loſs of one limb after another ſurviving but part of themſelves, and living to ſee themſelves dead and buried by piece-meal. Should I, to diſpatch, *Lindamor*, ſhew you all the ſeveral companies of mourners, that almoſt make up mankind, and diſcloſe to you, how copious ſhowers of tears do almoſt every where water (not to ſay overflow) this vale of miſeries; you would, perchance, ſee cauſe to think, that God's privative (if I may ſo ſpeak) may contend with his poſitive favours; and that you owe little leſs

for

* *Eſpecially ch.* 12. xvii. *Numb.* 5, 6.

Hab. i. 26.

Page 97.

Pſal. cx. 3.

Iſai. lxiv. 8.

for what you are not, than for what you are, to that diſcriminating mercy of his, to which alone you owe your exemption from miſeries, as great as the bleſſing it confers on you. For,
2 Cor. iv. *who maketh thee to differ?* is a queſtion, that may be as well aſked in reference to our external, as to our ſpiritual condition. Which invites me to mind you, *Lindamor*, that you are yet more engaged to God's love for protecting you from thoſe groſs vices, that diſfigure moſt men's minds, than from thoſe leſs dangerous, though more reſented diſeaſes, that diſtemper their bodies.

1 Pet. i. 18. For, *ambition*, *luſt*, *avarice*, *revenge*, and even that *vain converſation*, which young gentlemen are generally pleaſed to think ſo innocent, are really more formidable and pernicious diſeaſes and calamities, than thoſe, that reduce men to take phyſick, or thruſt them into hoſpitals. To evince the truth of which paradox, I hope I ſhall not need to mind you of judging of the dangerouſneſs of diſeaſes by the nobleneſs of that part affected, ſince I can tell you, that he, that cannot err, ſeems daily to juſtify our aſſertion, by inflicting ſickneſs and the ſharpeſt outward calamities on his own deareſt children, to preſerve them from the contagion of ſin, or cure them of the unfilial habitudes of it. And therefore, ſince, when we ſee a tender mother apply a painful cauſtick to the neck of her favourite-infant, threatned by the apoplexy, we ſcruple not to conclude, that ſhe thinks the trouble of an iſſue, an evil inferior to the convulſion fit: ſo when we ſee our heavenly father ſends infirmities and croſſes, to reſcue thoſe he loves, from the contagion or dominion of ſin; we may ſafely conclude, he thinks affection a leſs evil than guilt, ſince he is too wiſe and indulgent a phyſician to cure with a remedy worſe than the diſeaſe. In the eighth of *Deuteronomy*, there is a caution given the Iſraelites, leſt proſperity (which is wont to be a kind of *Lethe*, that makes men forget all but their enjoyments) ſhould make any of them ſay in his heart, *my power, and the might of*
Deut. viii. 17, 18. *my hand hath gotten me this wealth. But* (ſaith my text) *they ſhall remember the Lord their God; for he it is, that giveth them power to get wealth.* It is not the revolting Iſraelites only, of whoſe ignorance of his bounty God may complain, as he did by the prophet, by whom he ſaid, *I*
Hoſ. xi. 3. *taught Ephraim to go, taking them by their arms, but they knew not that I healed them:* and there are but too many, of whom he might
Hoſ. i. 8, 9. ſay, as he did by the ſame prophet: *For ſhe did not know, that I gave her corn, and wine, and oil, and multiplied her ſilver and her gold, which they prepared for Baal; therefore will I return and take away my corn in the time thereof, and my wine in the ſeaſon thereof, and will recover my wool and my flax given to cover her nakedneſs.* And this will make way for the deſign I had to recommend the advantageouſneſs of God's love, by ſaying, that as for ſpiritual goods, he gives us in this life ſo rich an earneſt of expected joys, that even the earneſt is a ſtock large enough to ſubſiſt with comfort on, and really out-values and tranſcends all thoſe momentary pleaſures, it requires us to forſake, to keep up a title to eternal ones. But to particularize God's mercies to us in this very life, would certainly take up a conſiderable part of it. And yet the love God bears us dies not with us, nor doth (as men's affections) either endure a funeral in our tombs, or ſurvive only in a uſeleſs grief, (or an eſteem as bootleſs.) No, God's love is ſo far from reſembling the uſual ſort of friends, who, when they have accompanied us to the grave, do there leave us; that, like the angels, that *carried Lazarus's ſoul* Luke xvi. 22. *to Abraham's boſom*, its officiouſneſs begins then moſt to appear, when our dark eyes are cloſed, and is then trueſt to the beloved ſoul, when ſhe forſakes the body; giving each bleſſed ſaint cauſe to ſay of God, what *Naomi* did of *Boaz*, Ruth ii. 20. that *he hath not left off his kindneſs to the living, and to the dead. Now*, indeed (ſays our Saviour's favourite) *are we the ſons of God, and* 1 John iii. 1. *it doth not yet appear what we ſhall be; but we know, when he ſhall appear, we ſhall be like him.* This bleſſed expectance muſt be now my theme, becauſe the narrow limits, which my deſign hath placed to this diſcourſe (of the advantages accruing from God's love) will leave no more room untaken up by heaven.

But, *Lindamor*, before I proceed to ſet forth *Sect.* 19. to you the greatneſs of the felicity reſerved for us in heaven, it will, I fear, be requiſite to mind you of the lawfulneſs of having an eye to it. For many, not undeſervedly, applauded preachers have of late been pleaſed to teach the people, that to hope for heaven is a mercenary legal, and therefore unfilial affection. Indeed, to hope for heaven as wages for work performed, or by way of merit, in the proper and ſtrict acception of that term, were a preſumption, to which none of the divines, we diſſent from, can be too much an enemy, nor perhaps more ſo than I am. But to take in God's bleſſings among the motives of loving God, is, but to do as he did, who ſaid, *I* Pſ. cxvi. 1. *love the Lord becauſe he hath heard my voice and my ſupplications*; and to look upon the joys of heaven, to comfort and ſupport us in the hardſhips and loſſes to be undergone in our journey thitherward, is to imitate no worſe a man than *Moſes*, of whom it is ſaid, that *he eſteemed the reproach of Chriſt greater riches than the treaſures in Egypt; for he had reſpect*, or turned his Heb. xi. 26. eye, (ἀπέβλεπε) *unto the recompenſe of the reward.* It is indeed, *Lindamor*, a happy frame of mind, to be able to love God purely for himſelf, without any glance at our own advantages. But though I dare not deny, that it is poſſible to attain to ſo high and diſintereſted a kind of love, yet I think, that that excellency ſuppoſed to be vouchſafed to ſome men, is not by the ſcripture exacted as a duty from all men. Were all the recompenſe of piety of a worldly nature, and to be here received, the actions inivited to, by the intuition of it, might paſs for mercenary. But when heaven is chiefly hoped for, as it will admit us unto the fruition of God himſelf in Chriſt, and that the other joys expected there are ſo far from being of a ſenſual or a worldly nature, that they are known not to be attainable, till by death, the ſenſes and bodies themſelves, and all the merely animal faculties be aboliſhed: for a heaven ſo conſidered

ſidered, I ſay, to forgo readily all the pleaſures of the ſenſes, and undergo chearfully all the hardſhips and dangers, that are wont to attend a holy life, is, *Lindamor*, ſuch a kind of mercenarineſs, as none, but a reſigned, noble, and believing ſoul is likely to be guilty of. If I ſhould ſay; that fear itſelf, and even the fear of hell, may be one juſtifiable motive of men's actions, though I ſhould propoſe, what thoſe I am reaſoning with would think a paradox; yet I ſhould perhaps hold forth therein no more than the ſcripture does, *Let us therefore fear*, (ſays the writer to the Hebrews) *leſt a promiſe being left us of entering into his reſt, any of you ſhall ſeem to come ſhort of it.* And no leſs eminent an herald of the goſpel than St. *Paul*, who ſucceſsfully maintained the evangelical againſt the legal ſpirit, thus profeſſeth of himſelf; *I keep under my body, and bring it into ſubjection, leſt by any means, when I have preached to others, I myſelf ſhould be a caſt-away.* And it was not to ſlaves or hirelings, that Chriſt directs this admonition; *I ſay unto you, my friends, be not afraid of them, that kill the body, and after that have no more that they can do: But I will forewarn you whom you ſhall fear; fear him, which, after he hath killed, hath power to caſt into hell; yea, I ſay unto you,* (a gemination, which the preſent controverſy ſhews not to have been cauſeleſs) *fear him.* Where the paraphraſe given of God is not barely deſcriptive, but ratiocinative, (to borrow thoſe terms of the ſchools) in warning us not only whom we ſhould, and ſhould not fear, but why we ſhould fear the one, and not the other. As when St. *Paul* ſays, *I know whom I have truſted*, he means what manner of perſon, how *faithful* (as St. *Peter* elſewhere calls God) *and how omnipotent:* whence immediately he adds, *And I am perſuaded, that he is able to keep that which I have committed unto him againſt that day.* More texts of the ſame import might be added, if the deſign of thoſe already alledged were other than to facilitate the admiſſion of the more plauſible truth we have been making out, and which to us ſeems very clearly held forth in thoſe and the like ſcriptures, which are therefore cited out of the new teſtament, that they might have the greater authority with one ſort of our antagoniſts. *I preſs toward the mark of the prize of the high calling of God in Chriſt Jeſus. Bleſſed are they, that do his commandments, that they may have right to the tree of life, and may enter in through the gates into the city; laying up in ſtore for themſelves a good foundation againſt the time to come, that they may lay hold of eternal life. To them, who by patient continuing in well-doing, ſeek for (ζητοῦσι) glory, and honour, and immortality, eternal life.* And of Chriſt himſelf, whoſe love to God is queſtionleſs filial and unequalable, it is ſaid, *Looking unto Jeſus the author and finiſher of our faith, who, for the joy that was ſet before him, endured the croſs, deſpiſed the ſhame, and is ſet down at the right hand of the throne of God.* Nor ſee I, why it ſhould be unfilial for a child of God to further the raiſing of thoſe paſſions, which his heavenly Father intends to have raiſed in him, upon the ſame grounds and motives, that God is pleaſed to employ to excite them. And ſince the ſcripture ſeems plainly to invite our hopes, by recording St. *Paul*'s having ſaid, *Every man, that ſtriveth for the maſtery, is temperate in all things; now they do it to obtain a corruptible crown, but we an incorruptible:* And by repreſenting our Saviour himſelf, as ſaying in one place, *Rejoice, and be exceeding glad, for great is your reward in heaven*: In another, *Be thou faithful unto death, and I will give thee a crown of life.* And in divers others ſpeaking to the like purpoſe; ſince, I ſay, the ſcripture ſeems thus to allure our hopes, would it not be a kind of accuſing it of an aptneſs to delude and enſnare us, to teach, that it propoſeth to us the powerfulleſt objects to incite our paſſions, if it be ſinful to cheriſh and harbour the paſſions naturally belonging to thoſe objects? And certainly, *Lindamor*, ſince God, who, as our Creator, knows the frame and conſtitution of man's ſoul, incomparably better than he himſelf, is pleaſed to deal with our hopes and our fears, to engage us to his ſervice; it very ill becomes us, either to quarrel with his methods of working on our ſpirits, or to reject any help, which he has been pleaſed to afford a piety, which, for aught ever I could obſerve, does even in the beſt men find reſiſtance enough to keep any help, that can be employed to promote it, from being ſuperſtitious. And truly, the animating or diſcouraging influence, that hope, or the want of it, is wont to have upon our endeavours, makes me very apprehenſive, that ſince the enlivening hopes of heaven are not able to make moſt men's endeavours other than very languid, the forbidding thoſe ſupporting hopes would ſoon weaken and decreaſe our endeavours into none at all.

Heb. iv. 1.
1 Cor. ix. 27.
Luk. xii. 4, 5.
1 Pet. iv. 19.
2 Tim. i. 12.
Phil. iii. 14.
Rev. xxii. 14.
1 Tim. vi. 19.
Rom ii. 17.
Heb xii. 2.
1 Cor. ix. 25.
Mat. v. 12.
Rev. ii. 10.

BUT, *Lindamor*, though I may perhaps have taken ſome pains in ſtudying controverſial divinity, yet I take ſo little pleaſure in writing of it, that though not only a ſeaſonable duty to truth, but a neceſſary one to the enſuing part of this diſcourſe, have preſſed me to ſerve in this cauſe; yet I ſhall perhaps obtain your pardon ſooner than my own, for having thus long ſuſpended the diſcourſing to you of the advantageouſneſs of God's love to us, as it gives us here a right, and will hereafter give us admiſſion to heaven; heaven, the bright ſeat of ſo much happineſs, that we ſhall ſcarcely count amongſt our joys, that heaven is the ſeat of them. There the excellency of the poſſeſſed goods ſhall as much diſappoint our expectations, as in other fruitions the emptineſs is wont to do. The Apoſtle tells us, that *eye hath not ſeen, nor ear heard, neither have entered into the heart of man, the things which God hath prepared for them that love him.* Such pure refined delights not only ſtoop not unto ſenſe, but are ſublime enough even to tranſcend imagination. When fancy hath formed and ſhaped the perfecteſt ideas, that its abſtractions can make, of bleſſedneſs; our own more happy experiences of greater muſt diſabuſe us, when we come to heaven; which is a ſoil, whoſe fruitfulneſs is ſo confined to joy, that even our diſappointments and miſtakes ſhall there contri-

Sect. 20.

1 Cor. ii. 9.

bute

bute to our happineſs; which will ſo much partake of his immenſity, whoſe gift it is, that you ſee the Apoſtle gives it a negative deſcription; and to create in us apprehenſions derogatory from what we ſhall poſſeſs, not only removes our thoughts from all we do enjoy, but exalts them above all that we can fancy. At which way of proceeding, that you may the leſs wonder, *Lindamor*, be pleaſed to conſider, that in heaven our faculties ſhall not only be gratified with ſuitable and acceptable objects, and, conſequently our capacities of happineſs as well increaſed as filled. A child not yet releaſed out of the homely priſon of the womb cannot there poſſibly frame ideas of thoſe delights, which will be afforded him by the pleaſing noiſes, and the glittering objects, that will preſent themſelves to him after his birth. And the ſame child, whilſt he continues in his nonage, though he may with delights look upon emblems finely drawn and painted, and may take ſome pleaſure in beholding the neat and ſurprizing characters and flouriſhes of a Greek and Hebrew bible curiouſly printed; yet he cannot then imagine the pleaſure the ſame objects will afford him, when age and ſtudy ſhall have ripened and inſtructed his intellectuals, and made him capable both of underſtanding and reliſhing the excellent moralities, couched in thoſe ingenious emblems, and the profound and ſaving myſteries, wherewith that divine book, the ſcripture, (eſpecially in its original tongues) does, to an intelligent and religious peruſer, appear repleniſhed. Such a double advantage, *Lindamor*, among others, the admiſſion into heaven brings thoſe, to whom that bleſſing is vouchſafed: for beſides that ſet of objects, (if I may ſo ſpeak) ſo new and ſo peculiar to heaven, that their ideas could never enter into men's thoughts before their admiſſion there; beſides this, I ſay, our then enlarged capacities will enable us, even in objects which were not altogether unknown to us before, to perceive things formerly undiſcerned, and derive thence both new and greater ſatisfactions and delights. Wonder not, *Lindamor*, that in mentioning the joys of heaven, I uſe the expreſſions I find leſs detractory from a theme, as much above our praiſes, as the heaven they are enjoyed in is above our heads. For, though ſuch expreſſions may ſeem ſomewhat tumid and aſpiring, and fitter much for one that celebrates, than for one that but aſſerts; yet cannot I ſcruple to uſe ſeeming hyperboles in the mention of felicities, which make the higheſt hyperboles but ſeeming ones. For thoſe joys, *Lindamor*, of heaven, are like its ſtars, which, by reaſon of our remoteneſs from them, appear extremely little, though really in themſelves they are ſo vaſt, that a leſs than the largeſt is by odds greater than the biggeſt object upon earth, nay, than the whole earth itſelf. And therefore as if I were to take you with me to contemplate the planets, I would ſhew you them through ſuch a teleſcope, as by a greatning thoſe bright objects in compariſon of what to an unaſſiſted eye they appear, doth ſomewhat leſſen the diſadvantage of remoteneſs, and ſhews them with leſs detraction from their true magnitude; ſo mentioning to you the felicities of heaven, I think it not unlawful or improper to endeavour, by repreſentations tranſcending what they appear, to give you notions leſs inferiour to what they are.

In heaven, then, we ſhall taſte happineſs enough, to enable us to rectify the definition of it. We may there be inſtructed, how to name and rate all goods, by thoſe that will concentre into the felicity we ſhall poſſeſs, which ſhall be there made up of the confluence, perfection, and perpetuity of all true joys. For heaven will make us happy, not (as philoſophy pretends to do) by the confinement, but by the fruition of our deſires; which ſhall neither fail in the choice of their objects, nor miſs of the enjoyment of them, but be both unerringly juſt, and infallibly accompliſhed; in the former of which properties, (as our then rectified reaſon will conſider things) we ſhall think our ſelves happier (yet) than in the latter. We ſhall there reſemble the ſaints we here admire, and ſhall not only ſee, and be like thoſe pious worthies, whoſe virtues eclipſe theirs, which among the heathen deified leſs deſerving heroes; thoſe excellent perſons, that did as well ennoble as inſtruct mankind, giving us cauſe to bluſh, that we are men, and whoſe ſtories have the unparallelled honour of being recorded by inſpired pens; thoſe ſpirits, I ſay, *of juſt men made perfect*, as the ſcripture terms them, Heb. xii. 23. ſhall be our conſtant and familiar company, into whoſe bleſſed ſociety we ſhall not only be welcome, but increaſe it. In heaven, we ſhall have a bleſſed and familiar converſation with thoſe ſame glorious ſpirits, whoſe nature doth inveſt them with ſuch a luſtre, that all the diſadvantage of their diſguiſes, when they appear to us, doth ſcarce ſuffice to confine our raptures to reſpects below idolatry, and darken them into objects for our wonder, not adoration. There we ſhall ſee (a ſight worthy dying for) that bleſſed Saviour, of whom the ſcripture does ſo much and ſo excellently entertain us, and who having done and ſuffered ſo much for us, does ſo highly deſerve of us, both upon the ſcore of his infinite perfections, and upon the account of his ineſtimable benefits. Yes, there ſhall we ſee that holy and divine perſon, who, when he vouchſafed (as his favourite-diſciple ſpeaks) *to pitch his tent among us*, and dwell with men on earth, to fit them by his merits and example to dwell with him in heaven, did ſo admirably mix an awful majeſty with an humble meekneſs, and the aſſumed infirmities of his human nature with the ſeaſonable coruſcations of his divine; and expreſſed in his whole life ſo perfect and exemplary a virtue, and yet ſo much ſweetneſs and gentleneſs towards thoſe aſpirers to it, that were the moſt ſhort of it; that the Jews themſelves could ſay of him, that *he had done all things well*; and his very enemies, that were employed to apprehend him as a malefactor, confeſſed even to thoſe, that ſent them to do ſo, that *never man ſpake like him*. And his Apoſtles, who had moſt opportunity to pry narrowly into his actions, and were of a condition and breeding very unlike to infuſe into them heroick reſo-

Ἐσκήνωσεν ἐν ἡμῖν. John i. 11.

Mat. vii. 37.

John vii. 46.

lutions, did, in ſpight of the frequent reproofs their failings extorted from him, and of the hardſhips that attended his ſervice, think even death it ſelf in his company, more eligible, than life led out of it; *let us alſo go, that we may die with him,*' (ſays even the diſtruſtful *Thomas* to his fellow-diſciples.) But, *Lindamor*, we ſhall there ſee the Son of God, not in that *form of a ſervant*, which he put on that he might ſuffer for us, and exerciſe his prieſtly and prophetick function here below; but in that regal ſtate and condition, which belongs to him by virtue of his kingly office; on whoſe ſcore he is ſtyled in the ſcripture, *King of Kings, and Lord of Lords*, all power or authority being (as himſelf ſpeaks) given him both in heaven and in earth. And how nobly attended may we ſuppoſe this divine monarch to be in his exalted condition in heaven, when in his ſtate of humiliation on earth, whilſt he was in the *wilderneſs among the wild beaſts, the angels* are recorded to have *miniſtred unto him*; and whilſt he lay ſwathed in a homely manger, the multitude of the celeſtial hoſt were heard to ſolemnize his miraculous birth, according to that paſſage of the writer to the Hebrews, *when he bringeth in the firſt-begotten into the world,* (he ſaith) *and let all the angels of God worſhip him!* And yet ſuch conſiderable and noble creatures thoſe immaterial intelligences, called angels, are, that one of them in one night was able to deſtroy above a hundred and fourſcore thouſand men in the blaſphemous *Senacherib*'s impious camp. And ſo much majeſty and ſuperiority does their nature give them in reference even to the eminenteſt of mortals, that when the undaunted *Joſhua* had boldly challenged one of them, that appeared to him in the likeneſs of a man, and demanded, whom he was for; when he knew him to be an angel, (unleſs he ſuppoſed him to be that promiſed Meſſiah, who is elſewhere called *the angel of the covenant*, as it is in the original, and in the ſame text *the Lord*) he alters his addreſs unto him into this ſubmiſſive one, *What ſaith my Lord unto his ſervant?* And even wiſe and holy *Daniel* himſelf, who was the ſecond perſon of the world for power, and the firſt for much nobler attributes, wiſdom, and underſtanding, who ſaw ſo many governors of vaſt provinces, and profeſſors of admired magick, inferiour to himſelf, yet confeſſes to the angel, that appeared to him, that he was confounded and diſanimated at his preſence, and adds, *How can the ſervant of this my Lord talk with this my Lord?* We may ſafely therefore expect, that we ſhall then behold our Saviour, not in thoſe diſguiſes, which diſfigured him in their eyes, that only conſidered his ſufferings; but in that triumphant condition, wherewith they are now rewarded. The thorns of his (now no more galling, but adorning) crown will appear upon that radiant head of his more glorious, than thoſe of the flaming buſh, wherein God appeared to *Moſes*. And we ſhall not ſee that deſpicable form, which made the prophet ſay, (perſonating the generality of the Jewiſh nation contemporary with the Meſſias) —*he hath no form, nor comelineſs, and when we ſhall ſee him, there is no beauty that we ſhould deſire.* But we ſhall ſee him encompaſſed with ſo much majeſty, and ſhining with ſo much of his genuine ſplendor and beauty, that we ſhall deſervedly eſteem him *Nephle, the Admirable.* And our raviſhed ſouls ſhall, by the more attentive contemplation of him, but find more cauſe to imitate the ſpouſe in *Solomon*'s myſtick epithalamium; who having dwelt upon the beauty of the ſeveral parts, that concurred to the accompliſhing the divine bridegroom, exclaims in an epiphonema, very contrary to the expreſſion lately mentioned in the prophet, he *is altogether deſires*, or by an Hebraiſm, *moſt deſirable*, which our Engliſh renders *he is altogether lovely.* His eyes will there appear as St. *John* repreſents them, of active fire, and will into the willing breaſts of the raviſhed beholders ſhoot flames as pure, as holy, and as deathleſs, as thoſe fathers of the church, who believed not the angels altogether incorporeal, may be ſuppoſed to have conceived the ſeraphims to conſiſt of. Certainly, ſince (as the ſcripture informs us) *it never entered into the heart of man, what God hath reſerved in heaven for thoſe that love him*; that glory can be but imperfectly expreſſed by the bare epithet of inconceivable, with which God rewards the meritorious ſufferings and obedience of that only begotten ſon of his love, for whoſe ſake he is pleaſed to confer on ſo many thouſands of men unimaginable glories. He, that vouchſafes even to many of his ſervants a brightneſs like that of the ſtars, will ſure communicate a more radiant luſtre to the *ſun of righteouſneſs*, that only ſon of his, *whom* (to borrow inſpired expreſſions) *he hath made heir of all things, by whom alſo he made the worlds: who being the brightneſs of his glory, and the expreſs image of his perſon, and upholding all things by the word of his power, when he had by himſelf purged our ſins, ſate down on the right hand of the majeſty on high, far above all principality, and power, and might, and dominion, and every name that is named, not only in this world, but in that which is to come.* Thereby exalting him not only above all earthly princes and potentates, but even above the higheſt orders of the ſpirits of the celeſtial hierarchy.

John. xi. 1.
Phil. ii. 7.
Rev. xix. 16.
Mat. xxviii. 18.
Mat. i. 13.
Luk. i.
Heb. i. 6.
2 King. xix. 35.
Mal. iii. 1.
Joſh. v. 13, 14.
Dan. x. 17.
Exod. iii. 2.
Iſa. liii. 2.
Iſa. ix. 6.
Cant. v. 10.
Rev. i. 14
Dan. xii. 3.
Mal. iv. 2.
Heb. i. 2, 3.
Eph. i. 21.

But apprehend not, *Lindamor*, that this ſublime exaltation of Chriſt will make him deſpiſe the meaneſt of his ſaints, or diſdain communion with him. For, St. *Paul* aſſures us, that he was in the *form of God*, when he vouchſafed to take upon him the form of a ſervant, to make us free: and ſure, he that condeſcended ſo far, and ſtooped ſo low, to invite and to bring us to heaven, will not refuſe us a gracious reception there. In the days of his fleſh he was pleaſed to own *Lazarus*, even in the diſhonours of the grave, and vouchſafed him in that deſpicable condition the glorious title of his friend; and when he deſcended the Mount of Olives, all the loud acclamations of the glad multitude, that ſang *Hoſannahs* to him, and ſtrewed his way with their palms, their veſtments, and their praiſes, could not divert him from deploring, even with tears, *Jeruſalem*'s approaching fate; and expreſſing in the midſt

Sect. 19.
Phil. ii. 7.
Luk. xix. 37, 38, 41.

of his triumphs, a concern for the very worſt and ſtubbornneſt of his enemies. And, leſt it ſhould be thought, that he was thus concerned for worthleſs mortals, only whilſt he ſhared and felt the miſeries of their condition; give me leave to obſerve to you, *Lindamor*, that immediately after his reſurrection, whilſt the ſenſe of the ſudden and unexampled change of his condition was freſh upon him, and the remembrance of the Apoſtles ingratitude in deſerting him, almoſt as recent, he ſticks not to give thoſe very diſciples, that forſook him, the glorious title (and that a more familiar one than we find him to have allowed them on earth) of his brethren; and particularly ſhews himſelf ſollicitous for that *Peter*, who, in ſpight of all thoſe empty boaſts, wherewith he not only ſeemed to defy death, but Chriſt's prediction too, did not only forſake his Maſter, but denied him. He can in heaven be ſo concerned for his diſtreſſed members here on earth, that not only he can take notice of expiring *Stephen*, thorough that cloud of fatal ſtones that battered down his priſon; and can, when *Saul* was perſecuting the vulgar Chriſtians, cry out unto him, *Saul, Saul, why perſecuteſt thou me?* as if he, and thoſe that love him, were but one; but in the meſſages he ſends to the Angels or governors of the ſeven churches, he ſufficiently manifeſts, that ſingle Chriſtians may be as particularly in his thoughts, as if they had no other object: his greatneſs will not make his kindneſs leſs familiar, but only more obliging; he diſdains not, even after his aſcenſion, to ſay, *Behold, I ſtand at the door and knock, if any man hear my voice, and open the door, I will come in to him, and will ſup with him, and he with me.* That king, in the parable, by whom himſelf is repreſented, is pleaſed himſelf to welcome each individual truſty ſervant with a peculiar *Euge, bone ſerve.* And in another parable he ſcruples not to repreſent the great condeſcenſions and familiarity, wherewith the Lord ſhall remunerate the faithful and watchful ſervant, by telling his diſciples, *Bleſſed are thoſe ſervants, whom the Lord, when he cometh, ſhall find ſo watching. Verily, I ſay unto you, that he ſhall gird himſelf, and will make them to ſit down to meat, and will come forth to ſerve them.* At which expreſſion you will the leſs admire, if you conſider, that beſides that it is parabolical, and probably hyperbolical, and therefore not to be taken (as the French ſpeak, *au pied de la lettre*) in a ſtrict ſenſe; we find in the evangelical ſtory, that our Saviour diſdained not to converſe familiarly with publicans and ſinners, nor even to waſh the feet of his own diſciples. And ſince he condeſcended to ſuch familiarity to thoſe frail mortals, ſo many of whom were apt to turn the favours of God into wantonneſs, we may the leſs admire at his gracious condeſcenſions to thoſe, the ſinleſſneſs of whoſe condition will keep them from turning his vouchſafements into any thing, but occaſions of joy and gratitude. Marvel not, *Lindamor*, as at an impertinency, that I appear ſo ſolicitous to poſſeſs you with high apprehenſions of the ſupereminent dignity and felicity of our exalted Saviour; and that in the loftieſt and moſt magnificent expreſſions, the ſcripture affords me, I have endeavoured to make out to you, that the bright ſun of righteouſneſs is now grown uncapable of ſuffering eclipſes, but ſhines with unclouded and unequalled ſplendor; and that we ſhall in heaven (as the writer to the Hebrews ſpeaks) *ſee Jeſus, who was made a little* (or for a ſhort while, βραχυ τι) *lower than the angels, for the ſuffering of death, crowned with glory, and honour.* For it will make heaven more heavenly to us, to find him reigning there, who hath ſuffered ſo much for us; and for whom, if we ever come thither, we ſhall have ſo much ſuffered. For, ſince our love will, as the reſt of our ſurviving graces, be perfected and grow compleat in heaven; the ineffable happineſs of our dear Redeemer muſt needs bring an increaſe to ours, commenſurate to the ardency of our love for him, and we ſhall reliſh no happineſs more than that, which is therefore ours, becauſe he is happy, and ſuppoſes in him, what it confers on us. Beſides that, ſince the regal dignity, wherein (as Mediator) he is inſtated, may make us owe our ſalvation to his ſentence, as well as to his merits; heaven itſelf will be ineſtimably endeared to us, by our injoying it upon his account. I need not tell you, what a value lovers are wont to ſet upon the leaſt favours, that can be beſtowed on them by their miſtreſſes; and that oftentimes a worthleſs ribband, a bracelet of hair, or ſome ſuch trifle, that nothing can make precious but her preſenting it, is highlier valued by the tranſported lover than the richeſt preſents of nature, or of fortune. How great a bleſſing muſt it then be, *Lindamor*, to owe joys, that need not endearing circumſtances to merit the name of happineſs, to a perſon ſo beloved, that even heaven itſelf will bring more felicity to the amorous ſoul, as it is a proof of his love, than that it is a donative of his bounty: as paſſionate brides do incomparably more value their wedding-rings which their glad lovers give them, as pledges, than as gold. It is ſaid of the perſecuted and diſgraced Apoſtles, that *they rejoiced to have been counted worthy to ſuffer ſhame for his name.* But if they deſervedly rejoiced to be allowed to ſuffer for him, of how much joy ſhall they have juſt cauſe, that are admitted to reign with him? His having ſupported the hardſhips and the toils (for I muſt not now call them evils) to which our afflicted condition of mortality is expoſed, does ſo much alleviate them, and refreſh us under them, that in this ſenſe alſo it may be truly ſaid, that *the chaſtiſement of our peace was upon him, and by his hurts we are healed.* But he that relieved us even by his croſs, will ſure do more for us by his crown, when he ſhall admit, and even invite, each faithful ſervant to no leſs a bleſſing than *to enter into his maſter's joy.* So rich a ſource of happineſs did Chriſt deſign to make himſelf to us in all his capacities and conditions, that in heaven and in earth, it was, and will be, his gracious and conſtant imployment to ſhare our griefs, or impart to us his joys; and either leſſen our miſeries by his ſufferings, or increaſe our happineſs by his felicity.

Matth. xxviii. 10. Mark xvi. 7. Acts vii. Acts ix. 4. *In the ſecond and third chapters of the* Apocalypſe. Rev. iii. 20. Matt. xxv. Luke xii. 37. Heb. ii. 9. Acts v. 41. Iſa. liii. 5. Matt. xxv. 21.

EXPECT not, *Lindamor*, that I ſhould ſolemnly

lemnly beg your pardon for this ſeeming excurſion, till I come to think it a digreſſion, to inſiſt on the bleſſedneſs of Chriſt in heaven, treating of the happineſs, which thoſe that love him will enjoy there. Wherefore, not to ſpend time in implóring á needleſs forgiveneſs, I ſhall proceed to tell you, *Lindamor*, that in heaven we ſhall not only ſee our elder brother Chriſt, but probably alſo our kindred, friends, and relations, that living here in his fear, died in his favour. For, ſince our Saviour tells us,
Luke xx. 36. that *the children of the reſurrection ſhall be* ἰσάγγελοι, *equal to*, or like *the Angels*; who yet, in the viſions of *Daniel* and St. *John*, appear to be acquainted with each other; ſince, in the
Luke xvi. parable of the miſerable Epicure, and the happy beggar, the father of the faithful is repreſented as knowing, not only the perſon, and preſent condition, but the paſt ſtory of *Lazarus*: ſince the inſtructer of the Gentiles confidently expects his converted and pious Theſſalonians,
1 Theſſ. ii. 19, 20. to be *his crown at that great day*, *when the having turned many to righteouſneſs*, ſhall, as the
Dan. ii. ſcripture foretels, confer a ſtar-like and immortal brightneſs: ſince (which is chiefly conſiderable) the knowledge of particular actions, and, conſequently, perſons, ſeems requiſite to the attainment of that great end of God, in the day of judgement, the manifeſtation of his punitive and remunerative juſtice: ſince, I ſay, theſe arguments, beſides divers others, are afforded us by the ſcripture, we may ſafely conclude it probable, that we ſhall know each other in a place, where, ſince nothing requiſite to happineſs can be wanting, we may well ſuppoſe (at leaſt, if we can imagine here, what we ſhall think there) that we ſhall not want ſo great a ſatisfaction, as that of being knowingly happy, in our other-ſelves, our friends. Nor is this only probable, *Lindamor*, but it is not improbable, that thoſe friends, that know us in heaven, ſhall welcome us thither. For, ſince Chriſt aſſures us, that the very angels (though they be ſo far from being related to our perſons, that they are foreigners to our very nature) receive acceſſion
Luke xv. 7. of joy for a relenting ſinner, that by repentance begins to turn towards God; you will think it abſurd, that in a place where charity ſhall
1 Cor. xiii. 8 not only continue (as St. *Paul* ſpeaks) but grow perfect, our dear friends ſhould rejoice to ſee us, not only begin to turn towards God, but come home to him. Nor is it unlikely, that our tranſported ſouls ſhall mutually congratulate each other, their having now fully eſcaped the numerous rocks, and ſhelves, and quick-ſands, and threatning ſtorms, and no leſs dangerous calms, through which they are at length arrived at that peaceful haven, where innocence and delight (which are here ſo ſeldom matched) are inſeparable companions, both of each other, and each bleſſed reſident. With thoſe friends we here lamented, we ſhall there rejoice. And it will be but need, that the diſcovery of each other's virtues ſhould bring us to a mutual knowledge of our perſons; for otherwiſe, we ſhall be ſo changed, that we ſhould never know our friends; and ſhould ſcarce know ourſelves, were not an eminent increaſe of knowledge a part of that happy change. For thoſe departed friends, whom at our laſt ſeparation we ſaw diſfigured by all the ghaſtly horrors of death, we ſhall then ſee aſſiſting about the majeſtick throne of Chriſt, with their once *vile bodies* Phil. iii. *tranſfigured into the likeneſs of his glorious* 21. *body*; mingling their glad acclamations with the hallelujahs of thrones, principalities, and powers, and the moſt dignified favourites of the celeſtial court. I need not tell you, *Lindamor*, that we ſhall be more juſtly tranſported at this meeting, than was good old *Jacob* at that of his ſon *Joſeph*, whom having long mourned for dead and loſt, he found not only alive, but a great favourite, ready to welcome him to an unknown court. For, whereas the patriarch ſaid to his ſon, *Now let me* Gen. xlvi. *die*, *ſince I have ſeen thy face*; the ſeeing of 30. our friends in heaven will aſſure us, that we ſhall for ever live with them there. The re-union of friends being there as privileged from divorce, as that of ſoul and body, (which ſcarce will be more ſtrict and ſatisfactory.) For, here indeed, if our friends do not allay our love or affection by unwelcome actions, or their contagious ſufferings, we commonly doat on them to a degree, that, as it were, reduces God to deprive us early of them, and ſnatch our idols, and his rivals, from us. But there, our, on both ſides, compleated graces will not only deſerve, but allow a higher ſtrain of friendſhip. The near contemplation and fruition of the infinitely tranſcendent perfections of the Creator, keeping all our kindneſs to the creatures not only ſubordinate to the love we owe to God, but grounded on it; as excited needles, when they ſtick faſteſt to each other, owe their union to their having both been touched by the load-ſtone; to which they have therefore both of them ſtronger inclinations, than either to the other.

THERE, probably, we ſhall ſatisfactorily *Sect.* 24. underſtand thoſe deep and obſcure myſteries of religion, which the profoundeſt clerks, that love not to flatter themſelves, acknowledge they are unable fully to comprehend; being, after all the toil and induſtry of their anxious enquiries reduced to ſit down with the Apoſtle's ὦ Βάθος, in admiration of that depth, whoſe Rom. xi. bottom they cannot fathom. There we ſhall 33. underſtand thoſe obſcure paſſages of (that divine book, and uncapable of flattery) the ſcripture, which, notwithſtanding all that bold criticks, and learned expoſitors, have attempted to illuſtrate it, does ſtill continue, in many places, obſcure. There, diſcerning how exquiſitely the ſeveral parts of ſcripture are fitted to the ſeveral times, perſons, and occurrences, wherein their all-foreſeeing author intended moſt to uſe them; we ſhall diſcern not only a reconcileableneſs, but a friendſhip, and perfect harmony, betwixt thoſe texts, that here ſeem moſt at variance; and ſhall diſcover not only the ſenſe of the obſcurer paſſages, but the requiſiteneſs of their having been written ſo obſcurely. That ſtrange and peculiar, as well as otherwiſe cryptical method and ſtyle of ſcripture, which often coſts us ſo much ſtudy to find

find it rational, we ſhall there diſcover to be admirable, and worthy of its omniſcient author. There, I hope, we ſhall have clearly expounded to us thoſe riddles of providence, which have, but too often tempted, even good men, to queſtion God's conduct in the government of the world; whilſt the calamities and perſecutions of virtue, and innocence, ſeem approved by him, who accumulates proſperities on their criminal oppoſers. There we ſhall be convinced, that all theſe ſeeming irregularities, which the heathen thought fit to impute to the giddy whimſies of a blind female deity, are not only conſiſtent with God's juſtice and goodneſs, but are productions of it. And though ſuch a belief do here, to intelligent perſons, ſeem perhaps a greater piece of ſelf-denial, than to refrain from wine, or gold, or miſtreſſes; yet in heaven it will appear as reaſonable, as here we find it difficult. For, as *Bildad* ſpeaks in *Job*, *We are but of yeſterday, and know nothing; becauſe our days upon earth are but a ſhadow.* And the ſhortneſs of our tranſitory lives not permitting us to continue long enough ſpectators here, to ſee above a ſcene or two at moſt of that great play, acted by mankind upon the ſtage of the world; it is no wonder we are apt to harbour ſiniſter thoughts of the contriver of a plot, whoſe neither beginning nor end we are acquainted with: which yet is little leſs injurious, than it were to cenſure the lofty tragedian *Seneca*, or ſome other matchleſs artiſt, having peruſed but a piece of ſome tragedy, whereof the latter part never arrived at our view. But, when once God's whole plot (if I may ſo ſpeak) and conduct in the adminiſtration of the world ſhall come to be diſcloſed; all thoſe revolutions and occurrences of empires, ſtates, families, and particular perſons, which men are here ſo prone to quarrel with, will there appear ſo juſt, ſo requiſite, and ſo ſeaſonable, that thoſe very things, which here tempted us to deny God, ſhall there engage us to praiſe him; and we ſhall not ſo properly be ſatisfied with his providence, as raviſhed. But eſpecially, we ſhall be tranſported with wonder and gratitude, when God ſhall vouchſafe to diſcover to his particular ſervants, the reaſons of his diſpenſations towards them, and make out to them not only the neceſſity and juſtice, but even mercifulneſs of thoſe very afflictions, that were moſt imputed to his ſeverity, (no ſtroke from God's paternal hand, either lighting ſooner, or falling heavier, or ſtaying longer, than the occaſion, that extorted it, exacted) and convince them, that their hopes were never diſappointed, but to ſecure their title to better things than thoſe they hoped for; nor their inferiour intereſts prejudiced, but for the advantage of their ſupreme ones. Yes, all that unwelcome darkneſs, that here ſurrounded our purblind underſtandings, will vaniſh at the dawning of that bright, and (as St. *Peter*'s * expreſſion may be interpreted) eternal day; wherein the reſolution of all thoſe difficulties, which here exerciſed (and perhaps diſtreſſed) our faith, ſhall be granted us to reward it. And I muſt profeſs to you, *Lindamor*, (as unfaſhionable as ſuch a profeſſion may ſeem in a gentleman not yet two and twenty) that I find the ſtudy of thoſe excellent themes, God's word, and his providence, ſo difficult, and yet ſo pleaſing and inviting, that could heaven afford me no greater bleſſing, than a clear account of the abſtruſe myſteries of divinity and providence, I ſhould value the having my underſtanding gratified and enriched with truths of ſo noble and precious a nature, enough to court heaven at the rate of renouncing for it all thoſe unmanly ſenſualities and trifling vanities, for which inconſiderate mortals are wont to forfeit the intereſt their Saviour ſo dearly bought them in it.

2 Pet. iii. 18. * ἡμέρα αἰώνιος.

NOR ſhall we only converſe with ſaints and angels, but with that infinitely more glorious Deity, that made them what they are, without at all impoveriſhing himſelf. In heaven, we ſhall enjoy (its maker) God, and *ſee him as he is*, who (as the ſcripture telleth us) ſhall then be *all in all*; compriſing all the goods, we value in the creatures, as eminently and fully, as the ſun doth the light, that twinkleth in the ſtars. *Sect.* 25. 1 John iii. 2. 1 Cor. xv. 28.

IF one, that was none of the leaſt of the philoſophers, ſcrupled not to tell the man, that aſked him, what he was born for, that it was to contemplate the ſun; if our beſt naturaliſts themſelves, though the darkneſs, that is here caſt upon things, and the dimneſs of our intellectual eyes, (which I remember *Ariſtotle* fitly compares to thoſe of an owl at noon-day) permit us to diſcern but very little of that wiſdom, power, and goodneſs, which he has expreſſed in the creation; are yet often tranſported and raviſhed with a juſt admiration of the perfections he has diſplayed in his workmanſhip: if the wiſe queen, that came ſo far to viſit *Solomon*, was put almoſt into an extaſy, by the ſight of his (though wiſe, yet human) ordering of things: and if the *angels themſelves* (as St. *Peter* informs us) *deſire to look into the myſterious contrivances of God*, in order to man's redemption: how great a ſatisfaction, *Lindamor*, may we juſtly conceive it muſt needs be, to be admitted to ſee ſo much of God, as heaven will diſcover to us? eſpecially, ſince ſo much of our future happineſs will conſiſt in that beatific viſion, (as the ſchool-men juſtly call it) that St. *John* concluded, that *we ſhall be like God*, becauſe *we ſhall ſee him as he is.* And our Saviour himſelf paraphraſes our celeſtial felicity by this bleſſed viſion, where he ſays, *Bleſſed are the pure in heart, for they ſhall ſee God:* As on the other ſide, the writer to the Hebrews employs the being denied the ſight of that divine object, as a deſcription of extreme wretchedneſs, in that text, where, having exhorted thoſe, to whom he writes, to *follow peace and holineſs*, he adds, as the formidableſt menace, which he could make uſe of, to deter them from ſlighting his exhortation, *without which, no man ſhall ſee the Lord.* And by this viſion our Saviour ſeems to deſcribe the happineſs even of angels; where, forbidding the ſcandalizing of any of thoſe little ones that believe in him, he adds, to enforce what he had ſaid, that *their angels do always ſee the face of his Father in heaven.* We ſhall be ſo taken up with *Anaxagoras.* 1 Pet. i. 12. 1 John iii. 2. Mat. v. 8. Heb. xii. 14. Mat. xviii. 10.

with the contemplation and fruition of that glorious object, (in whoſe infinity all goods are included and dilated) that ages, numberleſs as the joys that beatific viſion abounds with, will ſcarce afford us leiſure for a diverſion to any other pleaſures, than thoſe itſelf creates. Which are ſo numerous and ſo entire, that we ſhall there deſire nothing that we have not, except more tongues to ſing more praiſes to him, or at leaſt a capacity to pay him greater thanks for what we have. And even thoſe deſires, God's gracious acceptation will make, in being conceived, accompliſhed: for, otherwiſe heaven's reſidents ſcarce know any other want, than that of need to wiſh; the compleat bleſſedneſs of their condition reducing them to a happy uſeleſſneſs of wiſhes, by affording them a full prepoſſeſſion of all the objects of deſire. There time, like fire, having deſtroyed whatever it could prey on, ſhall, at laſt, die itſelf, and ſhall go out into eternity. Whoſe nature is ſuch, that though our joys, after ſome centuries of years, may ſeem to have grown elder, by having been enjoyed ſo many ages, yet will they really ſtill continue new, not only upon the ſcores of their welcomeneſs and freſhneſs, but by their perpetually equal (becauſe infinite) diſtance from a period. There our felicity ſhall always be the ſame, yet ever new. Wearineſs arguing imperfection, either in the object, or the appetite; the former of which is impoſſible in God, and the latter ſhall ceaſe in heaven. Where our felicity ſhall be ſo great, that variety itſelf ſhall not be needed as a part of it. And, if heaven do admit variety, it may be ſuppoſed ſuch a one, as ſhall conſiſt in a further knowledge of the firſt object (God,) not a forſaking of it; and ſuch as ariſes from the fixed beholding of the changing-necks of doves, or ſuch as we may ſee in the diverſified refractions of the ſame ſparkling diamond. In God there is (if I may ſo ſpeak) ſuch a various identity, that the fruition of him both ſatisfies and creates deſires: though that, without ſatiety; and this, without diſquiet. Other delights, like the uſual clothes we wear, quickly grow ſtale, and are ſoon worn out; whereas celeſtial pleaſures participate the prerogative of the Jews garments in the wilderneſs, of not impairing by being uſed long. But as the amorous needle, once joined unto the load-ſtone, would never, uncompelled, forſake the inchanting mineral; but, after ages, cling no leſs cloſely to it than at the firſt moment of their union: ſo do the ſaints in heaven, with the ſame undiminiſhed freſhneſs, ever poſſeſs their joys, as if each moment were the firſt, that they poſſeſſed them in. And, if their happineſs does not improve by laſtinger enjoyment, it is perhaps becauſe it was at firſt uncapable of increaſe. Or, if our pleaſures do admit acceſſion, they ſhall receive it from our aſſurance, that we ſhall taſte them for ever, and perpetually repeat (or rather continue) the ſame renewed fruitions to an eternity, endeared by nothing more, than by the quiet leiſure it will afford us, undiſtractedly to employ it, in celebrating of the author's praiſes; and in a condition, happier in that by it we grow paſt doing, than by paſt ſuffering ill. In heaven, (in a word) our inexhauſted joys will be ſo numberleſs, and ſo immenſe, that we ſhall need (as well as have) eternity itſelf to taſte them fully.

Deut. xxix. 5.

BUT, *Lindamor*, it was not my deſign to *Sect.* 26. give you a particular topography of this celeſtial *Canaan*; but only in a few words to let you ſee, that *it is a land flowing with milk and honey*. And though I acknowledge, I have given you but dark deſcriptions (and ſometimes rather poetical than chorographical) of what the Apoſtle ſtyles *the inheritance of the* Col. i. 12. *ſaints in light*: yet ſince, to whet our longings for fruitive (or experimental) knowledge, it is reſerved among the prerogatives of being in heaven, to know how happy we ſhall be, when there; and ſince, what the ſcripture hath revealed of paradiſe, ſeems meant rather to quicken our obedience, than ſatisfy our curioſity; I may, for thoſe purpoſes, have perhaps tolerably performed that taſk (of heavenly topography) by the acknowledgments of my diſability to do it worthily. I ſhall now only add this property of our expected bliſs, that the vaſt multitude of partners does detract nothing from each private ſhare, nor does the publickneſs of it leſſen propriety in it. This ocean of felicity being ſo ſhoreleſs, and ſo bottomleſs, that all the ſaints and angels cannot exhauſt it; it being as impoſſible for an aggregate of finites to comprehend or exhauſt one infinite, as it is for the greateſt number of mathematick points to amount to, or conſtitute a body. Our neighbour-regions do all enjoy the benefit of light as well as we; yet we enjoy not leſs, than if they enjoyed none. Indeed there is this difference between the ſun of righteouſneſs and that of heaven; that, whereas the latter, by his preſence, eclipſes all the planets, (his attendants;) the former, though radiant with a much brighter ſplendour, will, by his preſence, impart to his ſaints, according to that of the Apoſtle; *When Chriſt, who is our* Col. iii. 4. *life, ſhall appear, then ſhall we alſo appear with him in glory*. So that the elect, in relation to this ſun, ſhall not be like ſtars, which his ſhining obſcures and makes to diſappear; but, like poliſhed ſilver, or well-glazed arms, or thoſe vaſter balls of burniſhed braſs, the tops of churches are ſometimes adorned with, which ſhine not till they be ſhined upon, and derive their glittering brightneſs, and all the dazling fire that environs and illuſtrates them, from their being expoſed (unſkreened) to the ſun's refulgent beams. *I am my beloved's, and my* Cant. vi. *beloved is mine*, ſays every ſaint (with the ſpouſe 3. in the *Canticles*) to his Redeemer. *David* ſays of them that put their truſt in God, *That he* Pſal. *ſhall abundantly ſatisfy them with the fatneſs of* xxxvi. 6. *his houſe, and make them drink of the river of his pleaſures*: as if he meant to inſinuate, that, as when a multitude of perſons drink of the ſame river, none of them is able to exhauſt it, and yet each of them may have the full liberty of drinking as much as he can, or as much as he could, though none but himſelf ſhould be allowed to drink of it; ſo, whoſoever enjoys God, enjoys him wholly, or at leaſt doth enjoy

joy him ſo entirely, in relation to that man's capacity, that the fruition of whatſoever reſts unenjoyed of God is forbidden by the immenſity of the object, and not the pre-poſſeſſion of his rivals. The angels, though of a nature differing from ours, and thereby placed above the perſonal experience of our ſufferings and infirmities, do yet ſo ſympathize with us, that (as our Saviour informs us) they rejoice at the repentance of a ſinner. And, though the members of the Church-militant, and thoſe of the triumphant, live as far aſunder, as heaven is from earth, and are not more diſtant as to place, than differing as to condition; yet St. *Paul* reckons all the ſaints to be but *one family in heaven and in earth.* If then the diſparity of reſidences, of qualities, and of conditions, cannot now hinder the lovers of God from being ſo concerned in one another; how much of endearing kindneſs may we ſuppoſe, that they will interchange, when both their love ſhall be perfected, and all thoſe other graces too that are proper to cheriſh and increaſe it? For, the ſame Apoſtle, who, to aſſiſt us to conceive the ſtrictneſs of the union both betwixt Chriſt and his ſaints, and the ſaints among themſelves, tells us, that *he is the head, and they are his body, and members in particular*; teaches us to make this inference, that (to expreſs his doctrine in his own words) *If one member ſuffer, all the members ſuffer with it; and if one member be honoured, all the members rejoice with it.* Yes, *Lindamor*, in that bleſſed condition, our wills being perfectly conformed unto our Maker's, no ſaint nor angel can enjoy his love without poſſeſſing a proportionate degree of ours. And then, ſince perfect friendſhip appropriates to each friend the croſſes and proſperities of the other, (as good *Barzillai* could not be highlier obliged by *David*, than by the king's kindneſs to his ſon) each ſeveral beatitude in heaven ſhall (in ſome ſort concern the whole ſociety, and) be ours: as aſtronomers teach us, that the earth receives addition of light by the ſun's beams beſtowed upon the ſtars, and from the moon reflecting upon her. And becauſe our perſonal capacities are too too narrow, to contain all that joy, we are (by the ſtrange arithmetick of friendſhip) in a manner multiplied into as many happy perſons, as there are ſaints and angels bleſſed in heaven. Our perfect union to our common head, and mutual communion with each other, applying and bringing home every felicity of theirs to us: this friendly reciprocal ſympathy teaching us each glorified ſaint's bleſſedneſs, and him ours, by a bleſſed circulation, which makes us increaſe, by our reſenting them, thoſe joys (of others) whoſe increaſe we reſent.

Luke xv. 7.

Eph. iii 15.

1 Cor. xii. 27.

Ver. 26.

2 Sam. xix. 37.

But my thoughts are engaged in ſo good a company, *Lindamor*, that they keep me from conſidering, how faſt the hours paſs, and have almoſt made me forget, that the time, which my occaſions allowed me for ſcribling to you, is ſo far ſpent, that not now at laſt to reprieve you from the perſecution of my blunt pen, were to be almoſt as injurious to my own affairs, as to your patience. Hereafter yet I may poſſibly make you ſome amends for this, with riper diſcourſes of the nature and duties, or (if you will) the properties and returns of this love, to which I have hitherto preſented you ſome motives. To (the laſt of) which I might add, that, our love to the creatures is an earneſt, but to God it is a title; the one makes us the objects, but the other makes the object ours: that, ſince there is in love ſo ſtrange a magick, as to transform the lover into the object loved; we ought to be extremely careful of the dedication of a paſſion, which, as it is placed, muſt either dignify our nature, or degrade it: and not to addreſs to any lower (or, which is all one, to any other) object, the higheſt intenſity of a love, which cannot ſtoop without our degradation. And theſe I might expatiate on, and recruit them with many other motives, additional to thoſe I have already inſiſted on; but that I may more properly reſerve them to the treatiſe of the properties of that love, whoſe nature ſo partakes that of its object, that there can hardly be produced more powerful motives to it, than the conditions of it. Since then (as I freſhly intimated) I cannot but fear, that your tired patience, as well as my urgent occaſions (though theſe will recall me to-morrow morning to my own weſtern hermitage) doth at preſent ſummon me to leave you: and ſince I cannot do ſo in a happier place than heaven, I ſhall ſuſpend my farewels, only to beg you to believe, that ſo noble a motive of exalting friendſhip, as the ambition of rendering mine a fit return for yours, hath ſo improved my kindneſs, that my affection, without wronging its greatneſs, could not expreſs it ſelf by any leſs attempt than this of gaining you the greateſt, and the moſt deſirable of all goods, by elevating (that noble harbinger of your ſoul) your love to heaven: whoſe joys alone are not inferiour to thoſe, which the being made inſtrumental to procure them you would really create in,

My deareſt *Lindamor*,

From *Leeſe*, this 6th of *Aug.* 1648.

Your moſt faithful,

Moſt affectionate, and

Moſt humble Servant,

ROBERT BOYLE.

ADVER-

ADVERTISEMENT.

WHILST this fourth edition of the foregoing treatiſe was upon finiſhing, it happened, that a devout and very ingenious friend of the author's having preſſed to have the peruſal of ſome occaſional meditations, that lay by him, on ſeveral ſubjects, met, among others, with that which follows; and finding the ſubject to be of affinity with what is rather touched than inſiſted on, in the 65th page of the paſt treatiſe, * touching men's inability to praiſe God worthily, and having a great deal of partiality for the reflection, would needs have it annexed, as it was, to the newly finiſhed edition: notwithſtanding the author's having too juſt cauſe to urge, that, beſides the imperfections, that are made neceſſary by the ſublimity of the theme, ſuch occaſional papers, eſpecially his, are wont to have peculiar unaccurateneſſes, as being deſigned rather to entertain the writer himſelf, than any other reader.

[* page 169. of this volume.]

AN OCCASIONAL REFLECTION UPON A LETTER

Received in *April* 1662;

Containing an account of what paſſed on the King's Coronation-day, in a little country town.

I NEED not, *Pyrocles*, after what we have been reading, tell you, that the writer of this letter thinks, that both in what he has ſaid of the king, and in what he has done to ſolemnize his coronation, he has behaved himſelf rarely well. For I doubt not, but you eaſily diſcern by his way of writing, that he is highly ſatisfied with his performances, and expects, that he ſhall, if not be thanked by the king, at leaſt be mentioned in the news-book. But it will, I fear, be requiſite to tell you, that this honeſt man is not alone of his mind; for being his landlord's bailiff, he is eſteemed at that rate by his neighbours, and looked upon as a man very conſiderable in his pariſh; and is perhaps thought to have a right to pity moſt of thoſe, that do not admire what he has now been doing. And yet you and I, who pretend not to be courtiers, can, in his rural encomiums, and in his ill-contrived way of honouring his prince, eaſily diſcover ſo much that might have been mended, and ſo much that might be laughed at, that if the king, according to his wonted graciouſneſs, vouchſafe this action his ſmiles, it muſt not be in conſideration of the ſuitableneſs of the performances to the occaſion, but, partly as they proceed from a hearty, though ill-expreſſed, loyalty and love, and partly, as they afford him a ſubject of merriment. And not only the nice criticks, who have ſeen thoſe magnificent ſolemnities, and heard the eloquent panegyricks, wherewith the principal cities and aſſemblies in the nation have thought they did but part of what they ſhould; and not only thoſe aſſiduous courtiers, who, by the honour of a nearer acceſs, have opportunities (denied to others) of diſcovering thoſe particularities, that may beſt give a high veneration for a great perſon and a great prince, to thoſe, that are qualified to diſcern and reliſh ſuch things: not only theſe, I ſay, will have a quite other opinion of the rural praiſes, and antique ceremonies, that were ſo well liked a hundred miles from *London*; but this country-man himſelf, if he were admitted to the court, and bred a while there, would, in time, ſee ſo great a diſtance betwixt what he has done, and what a perſon better bred might have done, that he could not remember without bluſhes, what he now looks upon with triumph.

AND now I muſt on this occaſion confeſs to you, *Pyrocles*, that I have (on other riſes) ſeveral times been revolving in my thoughts, what the angels think of thoſe praiſes and deſcriptions of God, that men deviſe, (for I intend not here to ſpeak of thoſe the ſcripture ſuggeſts) and wherein we are moſt applauded by others, and do oftentimes, perchance, applaud our ſelves. For thoſe celeſtial courtiers (if I may ſo call them) have ſeveral advantages to aſſiſt them in the celebration of our common maſter, which we poor mortals want. For firſt, they are free from thoſe ſelfiſh and inordinate affections, that too often hinder us, either from diſcerning the excellency of divers of God's attributes and ways, or from duly acknowledging it. They have no ſins to keep them from deſcrying the juſtneſs of what he does; they have no ingratitude to oppoſe the fuller reſentments of his goodneſs; and they are not tempted, not to diſcern and adore his wiſdom, for fear they ſhould appear culpable for repining at his diſpenſations. And indeed, their longevity allowing them the full proſpect, from end to end, of thoſe intricate tranſactions of providence,

dence, of which, ſhort-lived mortals do commonly ſee but a part; they are queſtionleſs far more ſatisfied with the incomparably better contrivances they diſcern in the management of human affairs, than we are with the conduct or plots of the moſt ſkilfully written plays and romances. Beſides, thoſe happy ſpirits, of whom the ſcripture tells us, that *they ſtand before God*, and that they *continually ſee his face*, have by that privilege the bleſſed opportunities of diſcovering in the Deity they contemplate and ſerve, many excellencies, which even they could never, but by experience, have formed any thoughts of; and they ſee in one another's ſolemn adorations and praiſes a way of honouring the object of them, ſo much tranſcending the utmoſt of what we here aim at, that their homages to their Creator may well be ſuppoſed of a far nobler kind than ours. And laſtly, when I conſider, how much leſs unworthy thoughts and expreſſions touching things divine the ſame perſon may have, when come to his full maturity of age and parts, and whilſt he was but a child in both; and when I conſider, how much more advantageous conceptions of the wiſdom diſplayed in the univerſe, and particularly in the contrivance of a human body, one, that is a true philoſopher, and a ſkilful anatomiſt, may have, in compariſon of a man illiterate, and unacquainted with diſſections: when, I ſay, I conſider theſe things, and compare the dim twilight of human intellects in this life with that clear and radiant light, which the ſcripture aſcribes to angels; I cannot but think, that, having to the privilege of a much nearer acceſs than is allowed us to contemplate God's perfections, the advantage of having incomparably more illuminated intellects to apprehend them with, they muſt frame otherguiſe conceptions of the divine attributes, and glorify the poſſeſſor at an otherguiſe rate, than is allowed to thoſe, whoſe underſtandings are ſo dim, and whoſe reſidence is ſo remote from that bleſſed place, where the perfections they would extol are moſt diſplayed.

Luke i. Matth. xviii.

Assisted by theſe and the like advantages, *Pyrocles*, thoſe happy ſpirits may well frame notions, and employ expreſſions in honour of their Maker, ſo far tranſcending ours, that, though the angel's goodneſs keeps them, doubtleſs, from beholding them with contempt; yet, we may well think, they look upon them with ſuch a kind of pity, as that, wherewith great wits and courtiers look upon the miſtakes and imperfections of what they did and writ, when they were but ſchool-boys; and as that, wherewith, when we ſhall be admitted to the ſociety of the angels, we ſhall look back upon our former ſelves. No, *Pyrocles*, to praiſe God is a debt, which, though we ſhould ever be paying, we muſt always owe; not only becauſe the renewed obligations will laſt as long as we, but becauſe, though the intire ſum were poſſible to be paid, we have no coin of the value, that would be requiſite to make a payment of that nature. It is true indeed, that ſome men ſay much more than others upon a ſubject, on which none can ſay enough, and which even *the ſpirits of juſt men made perfect* can but imperfectly celebrate. It may be too, that the praiſes we pay to God procure us ſome from men, and perhaps even from orators and encomiaſts; and though I hope no man can ſo far flatter himſelf, as to think he can flatter what he can never do right to; yet the zealouſneſs of our endeavours, and the applauſe that others entertain them with, may perhaps tempt us to think, that, becauſe in our expreſſions we have ſurpaſſed our ſelves, we have almoſt equalled our theme: as if to make our praiſes too great for any other ſubject, were ſufficient to make them great enough for God. But alas, how widely muſt we be miſtaken! ſince our expreſſions, if we ſpeak ſenſe, can at beſt but fully repreſent our conceptions, and thoſe being but the notions of a finite creature, muſt needs fall extremely ſhort of perfections, which were not what they are, if they were not infinite. No, when we have employed the loftieſt hyperboles, and exhauſted all the celebrating topicks and figures of rhetorick; when we have dreſſed metaphyſical abſtractions in poetick raptures; when we have ranſacked whatever things are moſt excellent among the creatures, and having defæcated them, and piled them up together, have made that heap but a riſe to take our ſoaring flight from; when we have ſummed up, and left beneath our expreſſions, all that we are here wont to acknowledge above them; nay, when inſtructed, as well as inflamed, and tranſported by that *inacceſſible light*, that is inhabited by what we adore, we ſeem raiſed and elevated above all that is mortal, and above our ſelves, and ſay things, that nothing elſe could either inſpire or merit: even then, I ſay, thoſe expreſſions, which any otherwiſe applied would be hyperboles, do but expreſs our devotion, not the divine object of it, and declare how much we honour him, rather than what he is. And indeed, none but the poſſeſſor of an infinite intellect can be able to ſay, what the poſſeſſor of other infinite perfections deſerves to have ſaid of him. And whatever zealous ſkill we praiſe God with, we do far leſs honour him than injure him, if we think our aſpiringeſt praiſes can arrive ſo far, as, I ſay not to reach, but ſo much as to approach their ſubject.

1 Tim. vi. 16.

But, let not this inevitable impotence, *Pyrocles*, trouble, or diſcourage us. Thoſe bleſſed ſouls, that *follow the lamb whitherſoever he goes*, do (as we are taught in the Apocalypſe) make it their buſineſs, and find it their happineſs, to ſpend a great part of their eternity in extolling him, by whom they are placed in a condition, where they can have no employment, but what is holy and noble. And even here below, the praiſing of God is a work, wherein we imitate, though we do not equal the angels, and are buſied in the ſame employment, though not with the ſame ſkill. Nay, heaven it ſelf exempts not its reſidents from an impotence, which belongs to creatures, not as they are imperfect ones, but as they are creatures. Even the members of the church triumphant do not triumph over this neceſſary impotence; their praiſes may need pardon, even in a place where they can ſin no more; and they can expect but from

Rev. xiv. 4.

Heb. x.

God's goodneſs the acceptance of thoſe praiſes, that are improved, as well as occaſioned, even by their being made partakers of his glory. Nay, in the prophet *Iſaiah*'s extatick viſion, the Seraphim themſelves, that are introduced, as anſwering one another's glad acclamations to God, are likewiſe repreſented, as covering (out of reſpect) their faces with their wings. But, *Pyrocles*, as I was ſaying, this unavoidable diſability to ſay things worthy of God need not at all trouble us; ſince we pay our homages to one, whoſe goodneſs our expreſſions can as little equal, as they can his other attributes. He that created us, will not impute it to us, that we act but as creatures; and ſince he has declared, that *where there is a willing mind, a man is accepted according to what he has, and not according to what he has not*; the impotence I have been ſpeaking of, ought to bring us rather joy than trouble, ſince the infinite diſtance betwixt us, without leſſening his favourable acceptance of our praiſes, ſuppoſes the boundleſs perfections of him, whom thoſe praiſes (through his goodneſs) help to give us an intereſt in; and no ſon would repine at his royal father's greatneſs, how immenſe ſoever, being ſure, that greatneſs would not leſſen his kindneſs. For it is leſs deſirable to be able to deſcribe the power and excellencies of him we have an intereſt in, than to have an intereſt in one, whoſe power and goodneſs exceeds whatever we can ſay or fancy of them.

Iſa. vi. 2.

2 Cor. viii. 12.

To conclude, *Pyrocles*, ſince on the one ſide God is moſt truly ſaid in the ſcripture to be ſo *glorious, that he is exalted above all bleſſing and praiſe*, and conſequently, though *I could* (to uſe St. *Paul*'s phraſe) *ſpeak with the tongues of men and angels*; yet the higheſt things I could ſay of the divine perfections, muſt needs be therefore far below them, becauſe a creature were able to ſay them. And, ſince on the other ſide, it is of us men, that God vouchſafes to ſay, *whoſo offereth praiſe, glorifieth me*; and his tranſcendent excellency is ſo far from being inconſiſtent with a reſembling graciouſneſs, that ſuch a benignity is one of the moſt conſpicuous parts of it: I will not forbear to pay my praiſes unto one, whoſe deſerving infinitely more than I can offer keeps him not from accepting as much leſs than he deſerves. But then I muſt not preſume to *fill my mouth with his praiſes*, without ſenſibly acknowledging, that there is not any ſubject, whereon my expreſſions can more want eloquence, than on this ſubject; even eloquence it ſelf would want expreſſions.

Nehem. ix. 5. 1 Cor. xiii. 1.

Pſal. xxiii.

CERTAIN

CERTAIN PHYSIOLOGICAL ESSAYS, AND OTHER TRACTS;

Written at diſtant Times, and on ſeveral Occaſions.

[In the ſecond Edition, ſome of the Tracts were enlarged by Experiments, and the work increaſed by the addition of a Diſcourſe about *ABSOLUTE REST* in Bodies.]

An Advertiſement to the Reader: Prefixed to the firſt Edition, put forth *A. D.* 1661.

THE publiſher deſires, that the reader ſhould be informed, that neither were the following treatiſes written near about the ſame time (ſome of them being divers years older than ſome others) nor yet are they now publiſhed in the ſame order that they were written in. For the firſt of theſe diſcourſes (though penned about four years ſince) was not only written after the ſecond, third, and fourth, but after divers other eſſays, which the author has yet lying by him among his papers; it being intended for a kind of introduction to all thoſe treatiſes, which under ſeveral names, but chiefly that of *Phyſiological Eſſays*, the author had then compoſed. But having, during the late confuſions, ſo diſpoſed of his papers to ſecure them, that he could not himſelf ſeaſonably recover them; and being engaged by promiſe to ſome friends, to let about half a dozen of his ſmall tracts come abroad into the world by ſuch a time, he was fain to ſend the following treatiſes to the preſs as they came, ſome at one time, ſome at another, to his hands. And this his occaſions did now and then reduce him to do in ſuch haſte, that he could not attend the correcting either the printer's lapſes or his own, and particularly was obliged, partly by haſte, and partly by a diſtemper in his eyes, to ſend away the *Hiſtory of Firmneſs* without ſo much as reading it over. All which it is hoped the equitable reader will conſider in his favour, and bear with what may be imputable to ſuch circumſtances.

I Should add nothing further, were it not that to ſave the reader the trouble of gueſſing, who is meant by that *Pyrophilus*, to whom moſt of the following treatiſes are addreſſed, I think it requiſite to inform him, that the perſon veiled under that name, is that hopeful young gentleman, Mr. *Richard Jones*, only ſon to the Lord Viſcount *Ranelagh* and an excellent Lady, ſiſter to the author.

A

PROËMIAL ESSAY,

WHEREIN, WITH SOME

Conſiderations touching EXPERIMENTAL ESSAYS in general,

Is interwoven ſuch an Introduction to all thoſe written by the Author, as is neceſſary to be peruſed for the better underſtanding of them.

I KNOW not, *Pyrophilus*, whether what you will meet in the enſuing diſcourſes will prove worthy of your taking notice of; yet I dare tell you, that if all my endeavours to ſerve you were not duties, I ſhould think I might deſerve your thanks for venturing to write them for your ſake. For I am ſufficiently ſenſible, both how unlearned I am, and in how learned an age I preſume to write: nor has the great number of thoſe eſcaped my obſervation, who finding it a much eaſier taſk to cenſure experimental compoſures than to write ſuch, endeavour to acquire the title of judicious, by condemning all things, that themſelves have not written, or thought on. And indeed, *Pyrophilus*, I had, beſides theſe, ſo many other diſcouraging conſiderations in my eye, whilſt I was ſetting down the following eſſays, that I ſhould ſcarce have proſecuted a deſign ſo full of trouble, and ſo unlikely by its ſucceſs to make amends for it, if I had thought it free, for the ſecuring of my own quiet and credit, to ſuppreſs obſervations which might prove ſerviceable to you, who having ſufficiently converſed with books, are now deſirous to begin to converſe with things themſelves. But I muſt confeſs, I look upon experimental truths as matters of ſo great concernment to mankind, that in ſpite of the juſt ſenſe I have of my own diſabilities, I am deterred from complying with thoſe inclinations and motives that endear ſilence to me, by conſidering the fate of him, who though he had leſs entruſted to him than any of his companions, was yet ſeverely puniſhed for burying his ſingle talent. And though, *Pyrophilus*, I could not without ſuch reluctancy reſolve to write, yet I found it much more uneaſy to reſolve to write ſo ſoon. For I could not but conſider, that being yet but very young, not only in years, but, what is much worſe, in experience, I have yet much more need to learn, than ability to teach. And I conſidered too, that after a man is grown ſomewhat acquainted with things themſelves, and has taken ſome general notice of the cognations, differences, and tendencies of their properties, he may every day ſo much improve his knowledge, that I am apt to think, that if God ſhould be pleaſed to protract my life a few years longer, I ſhall at the end of them be able to look upon what I have hitherto written with pity, if not with bluſhes. And I have often obſerved, that it is wont to happen in the productions of the mind, as in thoſe of the body. For as thoſe, that apply themſelves to procreation too young, and before they have attained to their full vigour and ſtrength, do generally both hinder their own growth, and become the parents but of weak and ſhort-lived children; ſo they, that too early, and before their judgment and experience be fully ripe, addict themſelves to write books, do commonly both hinder their own proficiency in knowledge, and write but immature, and therefore ſeldom laſting treatiſes. Nor ſhould I, *Pyrophilus*, have ever prevailed with my ſelf to preſent you ſo early theſe diſcourſes, ſince, by keeping them longer by me, I might eaſily by ſecond thoughts, and freſh experiences, be enabled to correct and enrich them, did not the frequent and dangerous diſtempers, to which my very ſickly conſtitution has of late rendered me too obnoxious, make me juſtly doubt, whether or no, if I ſhould long forbear to write, death would not ſooner come than the expected maturity of age and judgment. And though I had no ſuch conſideration to move me to make haſte to tender to you the enſuing diſcourſes, yet this would ſuffice to engage me to preſent them you with all their preſent defects; that if I ſhould keep them till I can make them leſs unworthy of you, I muſt keep them till you are grown paſt the need of them.

AND now that I have told you, *Pyrophilus*, both why I have written the enſuing diſcourſes, and why I keep them not by me long enough to preſent them you with fewer imperfections; I ſuppoſe you will expect, that I ſhould next tell you, why I have caſt them into eſſays, rather than into any other form. To ſatisfy you about this particular, *Pyrophilus*, I muſt freely acknowledge to you, that it has long ſeemed to me none of the leaſt impediments of the real advancement of true natural philoſophy, that men have been ſo forward to write ſyſtems

of it, and have thought themſelves obliged either to be altogether ſilent, or not to write leſs than an entire body of phyſiology: for, from hence ſeem to have enſued not a few inconveniences.

AND firſt, when men, by having diligently ſtudied either chymiſtry, anatomy, botanicks, or ſome other particular part of phyſiology, or perhaps by having only read authors on thoſe ſubjects, have thought themſelves thereby qualified to publiſh compleat ſyſtems of natural philoſophy, they have found themſelves, by the nature of their undertaking, and the laws of method, engaged to write of ſeveral other things than thoſe, wherein they had made themſelves proficients; and thereby have been reduced, either idly to repeat what has been already, though perhaps but impertinently enough, written by others on the ſame ſubjects; or, elſe to ſay any thing on them rather than nothing, leſt they ſhould appear not to have ſaid ſomething to every part of the theme, which they had taken upon themſelves to write of.

IN the next place, the ſpecious and promiſing titles and comprehenſive method of theſe ſyſtems have been often found to perſuade unwary readers, that all the parts of natural philoſophy have been already ſufficiently explicated; and, that conſequently it were needleſs for them to put themſelves to trouble and charges in making further inquiries into nature, ſince others having already ſufficiently made it their buſineſs to inveſtigate and explicate phyſiological truths, our buſineſs needs now be no more than to learn what they have taught, and thankfully to acquieſce in it.

NOR has the ſyſtematical way of writing been prejudicial only to the proficiency of ſome readers, but alſo to the reputation of ſome writers of ſyſtematical books. For it not unfrequently happens, that when a writer, to vent ſome few peculiar notions or diſcoveries of his own, preſumes to write a whole body of philoſophy, what is truly his own, though excellent in its kind, is either loſt in the croud of the things he has borrowed from others, and ſo comes to be over-looked, or at leaſt not ſufficiently taken notice of, by the reader; or elſe the unwelcome, and yet in ſuch compoſures ſcarce evitable, repetition of many things, that others had, I know not how often, written before, occaſions the laying aſide of the whole book, as a rhapſody of trite and vulgar notions, ſcarce worth the peruſing. And by this means the author often loſes the reputation of his peculiar notions, as well as the reader the benefit of them; and that, which would have made an excellent and ſubſtantial eſſay, paſſes but for a dull and empty book.

BUT the worſt inconvenience of all is yet to be mentioned; and that is, That whilſt this vanity of thinking men obliged to write either ſyſtems or nothing is in requeſt, many excellent notions or experiments are, by ſober and modeſt men, ſuppreſſed; becauſe ſuch perſons being forbidden by their judgment and integrity to teach more than they underſtand, or aſſert more than they can prove, are likewiſe forbidden by cuſtom to publiſh their thoughts and obſervations, unleſs they were numerous enough to ſwell into a ſyſtem. And indeed it may be doubted, whether the ſyſtematical writers have not kept the world from much more uſeful compoſures than they have preſented it with. For there are very few men, if any at all, in the world, that are enriched with a competent ſtock of experiments and obſervations to make out clearly and ſolidly, I ſay not all the phænomena of nature, but all thoſe, that belong to chymiſtry, anatomy, or any ſuch conſiderable ſubordinate doctrine of phyſiology. And thoſe very men, that are diligent and judicious enough to ſtudy proſperouſly any of thoſe parts of phyſiology, are obliged to ſpend ſo much time in the accurate proſecution of that, and are wont to be thereby made ſo wary, and ſo thoroughly acquainted with the difficulty of phyſiological inveſtigations, that they will leaſt of all men be forward to write ſyſtems.

AND what I ſay, *Pyrophilus*, of the inconveniences, that have hitherto been obſerved to flow from men's forwardneſs to write entire bodies of philoſophy, may be, in its degree, applied to the practice of thoſe, that pretend to give us compleat accounts of chymiſtry, or almoſt (I ſay almoſt) any other conſiderable and comprehenſive part of natural philoſophy: though I deny not, that in ſuch attempts, which are much leſs difficult than the former, ſome men have done mankind conſiderable ſervice, though they have not fully performed what the titles of their writings ſeem to promiſe. Nor am I ſo rigid as to be unwilling, that, from time to time, ſome very knowing writer ſhould publiſh a ſyſtem of phyſiology, or any part of it, according to the beſt authors and obſervations of that time: for ſuch a work may be uſeful, partly, for the inſtructing of youth in ſchools and academies; and partly, that men may have, from time to time, an inventory of what hath been already diſcovered; whereby the needleſs labour of ſeeking after known things may be prevented, and the progreſs of mankind, as to knowledge, might the better appear. But then it is to be wiſhed, that ſuch writings were not publiſhed but by very intelligent perſons, nor till ſome conſiderable improvement have been made in knowledge ſince the laſt work of that nature. Nor would I be thought to diſallow ſuch writings of very learned men, as though they may bear very general titles, yet are not publiſhed by their authors as compleat bodies or ſyſtems of phyſiology, but rather as general principles, (almoſt like the hypotheſes of aſtronomers) to aſſiſt men to explicate the already known phænomena of nature. For of ſuch kind of writings, if their authors be (as for the moſt part they are) ſubtle and inquiſitive men, there may be very good uſe, not ſo much by their gratifying the intellect with the plauſible account of ſome of nature's myſteries; as becauſe on the one ſide their writers, to make good their new opinions, muſt either bring new experiments and obſervations, or elſe muſt conſider thoſe, that are known already, after a new manner, and thereby make us take notice of ſomething in them unheeded before; and on the other ſide,

the curiosity of readers, whether they like or disapprove the hypothesis proposed, is wont to be thereby excited to make trial of several things, which seeming to be consequences of this new doctrine, may, by their proving agreeable or repugnant to experiment, either establish or overthrow it.

AND that you may know, *Pyrophilus*, what kind of writings I mean, I shall name to you the learned *Gassendus* his little *Syntagma* of *Epicurus*'s philosophy, and that most ingenious gentleman Monsr. *Descartes* his principles of philosophy. For though I purposely refrained, though not altogether from transiently consulting about a few particulars, yet from seriously and orderly reading over those excellent (though disagreeing) books, or so much as Sir *Francis Bacon*'s *Novum Organum*, that I might not be prepossessed with any theory or principles, till I had spent some time in trying what things themselves would incline me to think; yet beginning now to allow my self to read those excellent books, I find by the little I have read in them already, that if I had read them before I began to write, I might have enriched the ensuing essays with divers truths, which they now want, and have explicated divers things much better than I fear I have done. But of such writers the number is yet (and will I fear always be) so small, that I shall not need to make many exceptions, when I treat of the usefulness of writing books of essays, in comparison of that of writing systematically: or, at least, *Pyrophilus*, whilst I presume not to judge of other men's abilities, I hope it may be lawful for me to confess freely to you concerning my self, that I am very sensible of my being far from having such a stock of experiments and observations, as I judge requisite to write systematically; and I am apt to impute many of the deficiencies to be met with in the theories and reasonings of such great wits as *Aristotle*, *Campanella*, and some other celebrated philosophers, chiefly to this very thing, that they have too hastily, and either upon a few observations, or at least without a competent number of experiments, presumed to establish principles, and deliver axioms. For it very rarely otherwise happens, than that theories, that are grounded but upon few and obvious experiments, are subject to be contradicted by some such instances, as more free and diligent inquiries into what of nature is more abstruse, or even into the less obvious qualities of things, are wont to bring to light. I remember, that being once at *Leyden*, I was brought to the top of a tower, where, in a darkened room, (such as is now used in many places to bring in the species of external objects,) a convex glass, applied to the only hole, by which light was permitted to enter, did project upon a large white sheet of paper, held at a just distance from it, a lively representation of divers of the chief buildings in the town; all which, upon the admission of more light into the room, by opening the window, did immediately disappear. And methinks, *Pyrophilus*, that in divers of the philosophical theories, that have been formerly applauded, something not unlike this may be easily observed: for though, whilst they are looked on with such a weak and determinate degree of light, they may appear very artificial and well-proportioned fabricks, yet they appear so but in that twilight, as it were, which is requisite to their conspicuousness. For if but a full light of new experiments and observations be freely let in upon them, the beauty of those (delightful, but fantastical) structures does immediately vanish.

AND truly, *Pyrophilus*, if men could be persuaded to mind more the advancement of natural philosophy than that of their own reputations, it were not, methinks, very uneasy to make them sensible, that one of the considerablest services, that they could do mankind, were to set themselves diligently and industriously to make experiments and collect observations, without being over-forward to establish principles and axioms, believing it uneasy to erect such theories, as are capable to explicate all the phænomena of nature, before they have been able to take notice of the tenth part of those phænomena, that are to be explicated. Not that I at all disallow the use of reasoning upon experiments, or the endeavouring to discern as early as we can the confederations, and differences, and tendencies of things: for such an absolute suspension of the exercise of reasoning were exceeding troublesome, if not impossible. And, as in that rule of arithmetick, which is commonly called *regula falsi*, by proceeding upon a conjecturally-supposed number, as if it were that, which we inquire after, we are wont to come to the knowledge of the true number sought for; so in physiology it is sometimes conducive to the discovery of truth, to permit the understanding to make an hypothesis, in order to the explication of this or that difficulty, that by examining how far the phænomena are, or are not, capable of being solved by that hypothesis, the understanding may, even by its own errors, be instructed. For it has been truly observed by a great philosopher, that truth does more easily emerge out of error than confusion. That then, that I wish for, as to systems, is this, that men, in the first place, would forbear to establish any theory, till they have consulted with (though not a fully competent number of experiments, such as may afford them all the phænomena to be explicated by that theory, yet) a considerable number of experiments, in proportion to the comprehensiveness of the theory to be erected on them. And, in the next place, I would have such kind of superstructures looked upon only as temporary ones; which though they may be preferred before any others, as being the least imperfect, or, if you please, the best in their kind that we yet have, yet are they not entirely to be acquiesced in, as absolutely perfect, or uncapable of improving alterations.

IT were very possible, *Pyrophilus*, to let you see, that all that has been said to recommend to you that form of writing, which (in imitation of the French) we call essays, is but a part of what may be pertinently said to the same purpose. But because this introductory discourse it self is to be but an essay, not a book, I dare not

not long inſiſt upon the advantages of this ſort of diſcourſes. Only becauſe I think, that if I could engage you, *Pyrophilus*, and ſuch other ingenious perſons, to caſt their phyſiological obſervations and reflections into experimental eſſays, I ſhould thereby do real learning no trifling ſervice, by bringing ſo uſeful a way of writing into the requeſt it deſerves; upon this conſideration, I ſay, I muſt beg leave to repreſent to you this great conveniency of eſſays, that as in them the reader needs not be clogged with tedious repetitions of what others have ſaid already, ſo the writer, having for the moſt part the liberty to leave off when he pleaſes, is not obliged to take upon him to teach others what himſelf does not underſtand, nor to write of any thing but of what he thinks he can write well. And if ſuch eſſays be but as they ſhould be competently ſtocked with experiments, it is the reader's own fault, if he be not a learner by them: for indeed when a writer acquaints me only with his own thoughts or conjectures, without inriching his diſcourſes with any real experiment or obſervation, if he be miſtaken in his ratiocination, I am in ſome danger of erring with him, and at leaſt am like to loſe my time, without receiving any valuable compenſation for that great loſs: but if a writer endeavours, by delivering new and real obſervations or experiments, to credit his opinions, the caſe is much otherwiſe; for let his opinions be never ſo falſe, his experiments being true, I am not obliged to believe the former, and am left at liberty to benefit my ſelf by the latter; and though we have erroneouſly ſuperſtructed upon his experiments, yet the foundation being ſolid, a more wary builder may be very much furthered by it in the erection of more judicious and conſiſtent fabricks. Such a writer, if I be not wanting to my ſelf, will certainly teach me uſeful truths, and if it be not my fault, he can lead me into no errors; and oftentimes the very experiments, that he delivers, beſides that they may be applicable to many other purpoſes unthought of by him, may be either ſufficient, or at leaſt helpful to the very diſcovery of the erroneouſneſs of the opinions they are alledged to countenance: and I may account, that a man, that gives me, together with his conjectures (though erroneous) in matters of phyſiology, ſome noble experiment or obſervation, by which he pretends to verify them, does me no greater injury, than *Galileo* upon his firſt invention of the teleſcope would have done an aſtronomer, if he had told him, that he had diſcovered in heaven thoſe imaginary new ſtars, which a late mathematician has fancied himſelf to have deſcried there, and at the ſame time had made him a preſent of an excellent teleſcope, with expectation that thereby the receiver ſhould be made of the giver's opinion; for by the help of his inſtrument the aſtronomer might not only make divers uſeful obſervations in the ſky, and perhaps detect new lights there, but diſcern alſo his miſtake, that gave it him.

AFTER what has been ſaid, *Pyrophilus*, of the uſefulneſs of experimental eſſays, we muſt proceed to ſay ſomething concerning the manner of writing them: but becauſe you will alſo expect to receive ſome account of the enſuing diſcourſes, I ſhall not treat of thoſe two ſubjects a-part, but, in diſcourſing of the following eſſays, ſhall take occaſion to acquaint you with part of my thoughts concerning ſuch kind of compoſures in general, the other conſiderations belonging to the ſame ſubject being already upon ſeveral occaſions diſperſed among, and to be met with in the enſuing diſcourſes themſelves.

AND firſt, as for the ſtyle of our experimental eſſays, I ſuppoſe you will readily find, that I have endeavoured to write rather in a philoſophical than a rhetorical ſtrain, as deſiring, that my expreſſions ſhould be rather clear and ſignificant, than curiouſly adorned: for to a ſubject of the ſerious and important nature of phyſiology that ſaying may unqueſtionably be applied, *Ornari res ipſa negat, contenta doceri.* And certainly in theſe diſcourſes, where our deſign is only to inform readers, not to delight or perſuade them, perſpicuity ought to be eſteemed at leaſt one of the beſt qualifications of a ſtyle; and to affect needleſs rhetorical ornaments in ſetting down an experiment, or explicating ſomething abſtruſe in nature, were little leſs improper, than it were (for him that deſigns not to look directly upon the ſun it ſelf) to paint the eye-glaſſes of a teleſcope, whoſe clearneſs is their commendation, and in which even the moſt delightful colours cannot ſo much pleaſe the eye, as they would hinder the ſight. And that it may not be ſuſpected, that thoſe, that would not have it requiſite to imploy a florid ſtyle in treating of philoſophical ſubjects, do but in their own excuſe deny the neceſſity of ſuch rhetorical embelliſhments as they are not able to afford their compoſures, give me leave to ſubjoin, that it was not an unpoliſhed naturaliſt, but that prince of orators, *Cicero* himſelf, who made this ſtudious declaration; *Omne* (ſays he) *quod de re bona dilucidè dicitur, præclarè mihi dici videtur: iſtiuſmodi autem res velle ornatè dicere, puerile eſt; planè autem & perſpicuè expedire poſſe, docti & intelligentis viri.* But I muſt not ſuffer my ſelf to ſlip unawares into the common place of the unfitneſs of too ſpruce a ſtyle for ſerious and weighty matters; and yet I approve not that dull and inſipid way of writing, which is practiſed by many chymiſts, even when they digreſs from phyſiological ſubjects. For though a philoſopher need not be ſollicitous, that his ſtyle ſhould delight its reader with his floridneſs, yet I think he may very well be allowed to take a care, that it diſguſt not his reader by its flatneſs, eſpecially when he does not ſo much deliver experiments or explicate them, as make reflections or diſcourſes on them: for on ſuch occaſions he may be allowed the liberty of recreating his reader and himſelf, and manifeſting, that he declined the ornaments of language, not out of neceſſity, but diſcretion, which forbids them to be uſed, where they may darken as well as adorn the ſubject they are applied to. Thus (to reſume our former compariſon) though it were fooliſh to colour or enamel upon the glaſſes of teleſcopes, yet to gild or otherwiſe

otherwiſe embelliſh the tubes of them, may render them more acceptable to the uſers, without at all leſſening the clearneſs of the object to be looked at through them.

AND as for exotick words and terms borrowed from other languages, though I expect, that perſons not converſant in the philoſophical compoſures written (eſpecially of late) in our language will be apt to ſuſpect me for the willing author of divers new words and expreſſions; yet as for you, *Pyrophilus*, who peruſe other than moral, theological, and hiſtorical books in Engliſh, and find how much uſe is made in them of exotick terms, I hope you will find, that I have not at all affected them, but have rather ſtudiouſly declined the uſe of thoſe, which cuſtom has not rendered familiar, unleſs it be to avoid the frequent and unwelcome repetition of the ſame word, (ſo troubleſome to the ear, and ſo much forbidden by orators) or for ſome peculiar ſignificancy of ſome ſuch word, whoſe energy cannot be well expreſſed in our language, at leaſt without a tedious circumlocution. And in ſuch caſes, *Pyrophilus*, I ſuppoſe a writer may be allowed to uſe exotick terms; eſpecially when cuſtom has not only denizen'd them, but brought them into requeſt. For, as in the faſhions of clothes, though perhaps fools begin them, yet wiſe men, when they are once generally received, ſcruple not to follow them, becauſe then obſtinately to decline them would be as ridiculouſly ſingular as at firſt it would have been to begin them: ſo in exotick words, when cuſtom has once made them familiar and eſteemed, ſcrupulouſly to decline the uſe of them may be as well a fault, as needleſly to imploy them: for it is not the uſe, but the affectation of them, that is unworthy a philoſopher. And from the latter of thoſe I hope I have kept my ſelf far enough; for I ſhould think my ſelf guilty of a very childiſh vanity, if the uſe I made of languages were ſo to write as to be the leſs underſtood. But beſides the unintentional deficiencies of my ſtyle, I have knowingly and purpoſely tranſgreſſed the laws of oratory in one particular, namely, in making ſometimes my periods or parentheſes over-long: for when I could not within the compaſs of a regular period compriſe what I thought requiſite to be delivered at once, I choſe rather to neglect the precepts of rhetoricians, than the mention of thoſe things, which I thought pertinent to my ſubject, and uſeful to you, my reader. And for this fault, *Pyrophilus*, ſince I have made my ſelf guilty of it but for your ſake, I think I ought to obtain your pardon at leaſt as eaſily as my own, ſince barely to keep you from loſing any thing, that I conceived might be ſerviceable to you, I knowingly expoſe my ſtyle to be cenſured as diſproportionate to it ſelf.

THE next thing, *Pyrophilus*, of which I am to give you an account, is, why I have in the enſuing eſſays delivered many experiments and obſervations, which may ſeem ſlight and eaſy, and ſome of them obvious alſo, or elſe perhaps mentioned by others already. To ſatisfy you about this, I muſt inform you, that many of the particulars, which we are now conſidering, were in my firſt deſign collected in order to a continuation of the Lord *Verulam*'s *Sylva Sylvarum*, or natural hiſtory. And that my intended centuries might reſemble his, to which they were to be annexed, it was requiſite, that ſuch kind of experiments and obſervations, as we have been newly ſpeaking of, ſhould make up a conſiderable part of them. And indeed it were to be wiſhed, that ſuch inquiſitive perſons, as cannot be at the charge, or have not the opportunity, of making new experiments, would buſy themſelves, as they have opportunity, in induſtriouſly collecting and carefully ſetting down the phænomena to be met with without the aſſiſtance of new experiments, eſpecially ſuch particulars, as ſeem either to be of moment in order to the hinting or confirmation of ſome conſiderable truth, or to the detection of ſome applauded error, or elſe to have been, though obvious enough, yet little taken notice of. For I am confident, that very much may be done towards the improvement of phyſiology by a due conſideration of, and reflexion on, the obvious phænomena of nature, and thoſe things, which are almoſt in every body's power to know, if he pleaſe but ſeriouſly to heed them; and I make account, that attention alone might quickly furniſh us with one half of the hiſtory of nature, as well as induſtry is requiſite, by new experiments, to enrich us with the other. And therefore I confeſs I think my ſelf beholden to him, that firſt makes me take notice of what I might eaſily have known, but heeded not before; it not ſeldom happening, that we are prejudiced by, though we do not complain of that ignorance, from which we might relieve our ſelves, if we did but diligently turn our eyes to the obſervations, wherewith even neighbouring and familiar objects would, if duly conſulted, preſent us. But I digreſs; and therefore muſt ſtep back into the way, and tell you, that the reaſons, why I firſt deſigned the narrative of what I had tried and obſerved for a continuation of Sir *Francis Bacon*'s Natural Hiſtory, you will meet with in my preface to that ſpecimen of the intended continuation, which I have given in thoſe of my eſſays, that treat of promiſcuous experiments: and the reaſon, why I have ſince declined that ſuccinct way of writing, is, for the ſake of *Pyrophilus*, that I might have, in a more free and uncircumſcribed way of diſcourſing, a greater liberty to inſiſt on and manifeſt the reaſonableneſs of ſuch animadverſions, as I thought ſeaſonable for a perſon, who, though a great proficient in the other parts of philoſophy, is but a beginner in experimental learning. And the ſecond reaſon, why I have often made uſe of ſeemingly ſlight experiments, is, becauſe ſuch are more eaſily and cheaply tried, and they being alleged for the moſt part to prove ſome aſſertion, or credit ſome admonition, I thought their eaſineſs or obviouſneſs fitter to recommend them, than depreciate them; and I judged it ſomewhat unkind, or at leaſt indiſcreet, to refer you moſt commonly for proof of what I delivered, to ſuch tedious, ſuch difficult, or ſuch intricate proceſſes, as either you can ſcarce

well make, unleſs you be already, what I deſire my experiments ſhould help to make you, a ſkilful chymiſt; or elſe are as difficult to be well judged, as the truth they ſhould diſcover is to be diſcerned. I was alſo hopeful, that the eaſineſs of divers things inviting you to make trial of them, and keeping you from being diſappointed in your expectations, the ſucceſs of your firſt attempts would incourage you to make trial alſo of more nice and difficult experiments. And till you have tried them, do me the right to think, that I deal not unſincerely with you.

THE reaſons of my having divers times recorded experiments, which you may have formerly met with, and perchance even in printed books, I have elſewhere deduced in a peculiar diſcourſe on that ſubject; and therefore ſhall now only add, that by reaſon of my being as yet a ſtranger to the German tongue, wherein the moſt and beſt chymical books are ſaid to be written, I may have ſet down divers chymical experiments and obſervations, that are extant already in that Hermetical language, (if I may ſo call it) without having had them from their Dutch publiſhers, or ſo much as dreamed of their having been divulged by any man. I have likewiſe in my preface to the eſſays, that you will meet with under the title of *Promiſcuous Experiments*, given you an account, why I have not refrained from mentioning divers things, which may ſeem very ſlight, becauſe very obvious: and I have long had thoughts to inform you in an intire diſcourſe to be written onpurpoſe, why I think, that even the trivial, and therefore ſlighted, truths of phyſiology ought not to be deſpiſed. And for my own part, I ſhall not ſcruple to confeſs to you, that I diſdain not to take notice even of ludicrous experiments, and think, that the plays of boys may ſometimes deſerve to be the ſtudy of philoſophers: for as when we go a hunting, though the flight of the hare and the purſuit of the dogs be to us but ſport and recreation, yet the beaſts themſelves are extreamly earneſt, the one to ſave his threatened life by flight, and the other to overtake his deſired prey; ſo nature acts very ſeriouſly in all the other things, that we make ſports with, and is in very good earneſt, whether we men be ſo or no.

PERHAPS you will wonder, *Pyrophilus*, that in almoſt every one of the following eſſays I ſhould ſpeak ſo doubtingly, and uſe ſo often, *perhaps*, *it ſeems*, *it is not improbable*, and ſuch other expreſſions, as argue a diffidence of the truth of the opinions I incline to, and that I ſhould be ſo ſhy of laying down principles, and ſometimes of ſo much as venturing at explications. But I muſt freely confeſs to you, *Pyrophilus*, that having met with many things, of which I could give myſelf no one probable cauſe, and ſome things, of which ſeveral cauſes may be aſſigned ſo differing, as not to agree in any thing, unleſs in their being all of them probable enough; I have often found ſuch difficulties in ſearching into the cauſes and manner of things, and I am ſo ſenſible of my own diſability to ſurmount thoſe difficulties, that I dare ſpeak confidently and poſitively of very few things, except of matters of fact. And when I venture to deliver any thing, by way of opinion, I ſhould, if it were not for mere ſhame, ſpeak yet more diffidently than I have been wont to do. It is not, that I at all condemn the practice of thoſe inquiſitive wits, that take upon them to explicate to us even the abſtruſeſt phænomena of nature; for I am ſo far from cenſuring them, that I admire them, when their endeavours ſucceed, and applaud them even where they do but fairly attempt. But I think it is fit for a man to know his own abilities and weakneſſes, and not to think himſelf obliged to imitate all that he thinks fit to praiſe. I know alſo, that the way to get reputation is to venture to explicate things, and promote opinions; for by that courſe a writer ſhall be ſure to be applauded by one ſort of men, and be mentioned by many others; whereas by the way of writing, to which I have condemned myſelf, I can hope for little better among the more daring and leſs conſiderate ſort of men, ſhould you ſhew them theſe papers, than to paſs for a drudge of greater induſtry than reaſon, and fit for little more, than to collect experiments for more rational and philoſophical heads to explicate and make uſe of. But I am content, provided experimental learning be really promoted, to contribute even in the leaſt plauſible way to the advancement of it; and had rather not only be an under-builder, but even dig in the quarries for materials towards ſo uſeful a ſtructure, as a ſolid body of natural philoſophy, than not do ſomething towards the erection of it. Nor have my thoughts been altogether idle and wanting to themſelves, in framing notions, and attempting to deviſe hypotheſes, which might avoid the deficiences obſerved in other men's theories and explications: but I have hitherto, though not always, yet not unfrequently, found, that what pleaſed me for a while, as fairly comporting with the obſervations, on which ſuch notions were grounded, was ſoon after diſgraced by ſome further or new experiment, which at the time of the framing of thoſe notions was unknown to me, or not conſulted with. And indeed I have the leſs envied many (for I ſay not all) of thoſe writers, who have taken upon them to deliver the cauſes of things, and explicate the myſteries of nature, ſince I have had opportunity to obſerve, how many of their doctrines, after having been for a while applauded, and even admired, have afterwards been confuted by the diſcovery of ſome new phænomenon in nature, which was either unknown to ſuch writers, or not ſufficiently conſidered by them. For I have found it happen, as well to many others (that have publiſhed their opinions) as to me (who have been more private in my gueſſes) in our theories built on either too obvious or too few experiments, what is wont to happen to the falſifiers of coin; for as counterfeit pieces of money will endure ſome of them one proof, as the touch-ſtone, others another, as aqua fortis, ſome a third, as the hammer or the ſcales, but none of them will endure all proofs; ſo the notions I mention (in which ſort I fear too

great a part of thoſe hitherto extant may be comprized) may agree very fairly with this or that or the other experiment; but being made too haſtily, and without conſulting a competent number of them, it is to be feared, that there may ſtill after a while be found one or other, (if not many) their inconſiſtency with which will betray and diſcredit them.

I HAVE notwithſtanding all this, on ſome occaſions, adventured to deliver my opinion; not that I am very confident of being leſs ſubject to err in thoſe particulars, than in any of the others, wherein I have refrained from interpoſing any conjecture; but becauſe I would manifeſt to you, that I ſcruple not to run the ſame venture with thoſe incomparably better naturaliſts, that have thought it no diſgrace in difficult matters rather to hazard the being ſometimes miſtaken, than not to afford inquiſitive perſons their beſt aſſiſtance towards the diſcovery of truth.

AND becauſe, *Pyrophilus*, in the reaſons and explications I offer of natural effects, I have not for the moſt part an immediate recourſe to the magnitude, figure, and motion of atoms, or of the leaſt particles of bodies, I hold it not unfit to give you here ſome account of this practice; not ſo much for the ſake of thoſe few paſſages in my eſſays, that may be concerned in it, as for that of many learned men, eſpecially phyſicians, whoſe uſeful writings being to be undervalued, and are in danger to be deſpiſed, by an opinion taken up from the miſ-underſtood doctrine of ſome eminent Atomiſts, as if no ſpeculations in natural philoſophy could be rational, wherein any other cauſes of things are aſſigned than atoms and their properties. I conſider then, that generally ſpeaking, to render a reaſon of an effect or phænomenon, is to deduce it from ſomething elſe in nature more known than itſelf; and that conſequently there may be divers kinds of degrees of explication of the ſame thing. For although ſuch explications be the moſt ſatisfactory to the underſtanding, wherein it is ſhewn, how the effect is produced by their more primitive and catholick affection of matter, namely, bulk, ſhape and motion; yet are not theſe explications to be deſpiſed, wherein particular effects are deduced from the more obvious and familiar qualities or ſtates of bodies, ſuch as heat, cold, weight, fluidity, hardneſs, fermentation, *&c.* though theſe themſelves do probably depend upon thoſe three univerſal ones formerly named. For in the ſearch after natural cauſes, every new meaſure of diſcovery does both inſtruct and gratify the underſtanding; though I readily confeſs, that the nearer the diſcovered cauſes are to thoſe, that are higheſt in the ſcale or ſeries of cauſes, the more is the intellect both gratified and inſtructed.

I THINK it therefore very fit and highly uſeful, that ſome ſpeculative wits, well verſed in mathematical principles and mechanical contrivances, ſhould employ themſelves in deducing the chiefeſt modes or qualities of matter, ſuch as are heat, cold, *&c.* and the ſtates or conditions of it, (if we think fit to diſtinguiſh theſe from its qualities) as fluid, firm, brittle, flexible, and the like, from the above-mentioned moſt primitive and ſimple affections thereof. And, I think, the commonwealth of learning exceedingly beholden to thoſe heroick wits, that do ſo much as plauſibly perform ſomething in this kind. But I think too, we are not to deſpiſe all thoſe accounts of particular effects, which are not immediately deduced from thoſe primitive affections of either atoms, or the inſenſible particles of matter; but from the familiar, though not ſo univerſal, qualities of things, as cold, heat, weight, hardneſs, and the like. And perhaps it would be none of the leaſt advantages, which would accrue to Naturaliſts from a ſatisfactory explication of ſuch qualities by the moſt primitive and ſimple ones, that it would much ſhorten the explication of particular phænomena. For though there be many things in nature, that may be readily enough made out by the ſize, motion, and figure of the ſmall parts of matter; yet there are many more, that cannot be well explained without a great deal of diſcourſe, and divers ſucceſſive deductions of one thing from another, if the purpoſed effect muſt be deduced from ſuch primary and univerſal cauſes; whereas if we be allowed to take the notions of cold, heat, and the like qualities for granted, the explications and proofs may be much more compendiouſly made. He gives ſome reaſon, why ſtones and iron, and all other heavy bodies, will ſwim in quickſilver, except gold, which will ſink in it; that teaches, that all thoſe other bodies are *in ſpecie*, (as they ſpeak,) or bulk for bulk, lighter than quickſilver, whereas gold is heavier. He, I ſay, may be allowed to have rendered a reaſon of a thing propoſed, that thus refers the phænomenon to that known affection of almoſt all bodies here below, which we call gravity, though he does not deduce the phænomenon from atoms, nor give us the cauſe of gravity; as indeed ſcarce any philoſopher has yet given us a ſatisfactory accountof it. So if it be demanded, why, if the ſides of a blown bladder be ſomewhat ſqueezed betwixt one's hands, they will, upon the removal of that which compreſſed them, fly out again, and reſtore the bladder to its former figure and dimenſions; it is not ſaying nothing to the purpoſe, to ſay, that this happens from the ſpring of thoſe aërial particles, wherewith the bladder is filled, though he, that ſays this, be not perhaps able to declare, whence proceeds the motion of reſtitution, either in a particle of compreſſed air, or any other bent ſpring.

AND as for the reaſons of things aſſigned by phyſicians, they muſt be by moſt of them deſpiſed, unleſs we will allow of ſuch explications, as deduce not things from atoms or their affections, but only either from ſecondary qualities, or from the more particular properties of mixt bodies. If a phyſician be aſked, why rhubarb does commonly cure looſeneſſes, he will probably tell you as a reaſon, that rhubarb is available in ſuch diſeaſes, becauſe it hath both a laxative virtue, whereby it evacuates choler, and ſuch other bad humours as are wont, in ſuch caſes, to be the peccant matter; and an aſtringent quality, whereby it afterwards ar-

reſts the flux. But if you further aſk him the reaſon, why rhubarb purges, and why it purges choler more than any other humour; it is ten to one he will not be able to give you a ſatisfactory anſwer. And indeed, not only the manner, whereby purgative medicines work, but thoſe other properties, whereby ſome bodies are diuretick, others ſudorifick, others ſarcotick, *&c.* are not, I fear, ſo eaſy to be intelligibly made out as men imagine, and yet a ſkilful phyſician would juſtly think himſelf wronged, if the reaſons he renders of things in his own profeſſion were denied the name of reaſons, becauſe made without recourſe to atomical principles. And indeed, there are oftentimes ſo many ſubordinate cauſes between particular effects and the moſt general cauſes of things, that there is left a large field, wherein to exerciſe men's induſtry and reaſon, if they will but ſolidly enough deduce the properties of things from more general and familiar qualities, and alſo intermediate cauſes (if I may ſo call them) from one another. And I am the more backward to deſpiſe ſuch kind of reaſons, becauſe I elſewhere declare, that there are ſome (for I do not ſay, many) things, as particularly the origin of local motion, of which, even by the atomical doctrine, no phyſical cauſe can well be rendered; ſince either ſuch things muſt be aſcribed to God, who is indeed the true, but the ſupernatural cauſe of them; or elſe it muſt be ſaid, (as it was by the old Epicureans) that they did ever belong to matter: which, conſidering that the notion of matter may be compleat without them, is not to give a phyſical efficient cauſe of things in queſtion, but in effect to confeſs that they have no ſuch cauſes. But of this elſewhere more.

IN the mean time, that you may not be drawn away to undervalue ſuch writers as I have been pleading for, nor think you ought to refrain from writing what occurs to you, though true and uſeful, unleſs you deduce it, or at leaſt can do ſo, from the Epicurean notions; I ſhall here briefly repreſent to you, (what perhaps you will not hereafter think a deſpicable ſuggeſtion) that there are two very diſtinct ends, that men may propound to themſelves in ſtudying natural philoſophy. For ſome men care only to know nature, others deſire to command her; or, to expreſs it otherwiſe, ſome there are, who deſire but to pleaſe themſelves by the diſcovery of the cauſes of the known phænomena; and others would be able to produce new ones, and bring nature to be ſerviceable to their particular ends, whether of health, or riches, or ſenſual delight. Now as I ſhall not deny, but that the atomical, the Carteſian, or ſome ſuch principles, are likely to afford the moſt of ſatisfaction to thoſe ſpeculative wits, that aim but at the knowledge of cauſes; ſo I think, that the other ſort of men may very delightfully and ſucceſsfully proſecute their ends, by collecting and making variety of experiments and obſervations; ſince thereby learning the qualities and properties of thoſe particular bodies they deſire to make uſe of, and obſerving the power that, divers chymical operations, and other ways of handling matter, have of altering ſuch bodies, and varying their effects upon one another, they may, by the help of attention and induſtry, be able to do many things, ſome of them very ſtrange, and more of them very uſeful in human life. When a gunner or a ſoldier employs gun-powder, it is not neceſſary, that he ſhould conſider, or ſo much as know, of what, and of how many ingredients (much leſs of what kind of atoms) it is made, and the proportion and manner, wherein they are mingled; but the notice experience gives him of the power of that admirable concrete, as it is made up and brought to his hands, ſuffices to enable him to perform things with it, that nothing but their being common and unheeded can keep from being admired. The phyſician, that has obſerved the medicinal virtues of treacle, without knowing ſo much as the names, much leſs the nature of each of the ſixty and odd ingredients, whereof it is compounded, may cure many patients with it. And though it muſt not be denied, that it is an advantage as well as a ſatisfaction, to know in general, how the qualities of things are deducible from the primitive affections of the ſmalleſt parts of matter; yet whether we know that or no, if we know the qualities of this or that body they compoſe, and how it is diſpoſed to work upon other bodies, or be brought on by them, we may, without aſcending to the top in the ſeries of cauſes, perform things of great moment; and ſuch, as, without the diligent examination of particular bodies, would, I fear, never have been found out *à priori*, even by the moſt profound, contemplators. We ſee that the artificers, that never dreamed of the Epicurean philoſophy, have accommodated mankind with a multitude of uſeful inventions. And *Paracelſus*, who (beſides that he ſeems none of the moſt piercing and ſpeculative wits) ſure had little recourſe to atomical notions, if he ever ſo much as heard of them, was able to perform ſome things, that were truly admirable, beſides thoſe he vainly boaſted of; as may appear not only by what I elſewhere repreſent, but by what *Oporinus* himſelf (as ſeverely as he otherwiſe writes againſt his deſerted maſter) confeſſes he ſaw of the ſtupendous cures, which *Paracelſus* wrought with his famous *Laudanum*, (whatever he made it of.) But we need not go far to find a noble example to our preſent purpoſe, ſince we ſee, that the bare making of trials with the load-ſtone, and irons touched by it, though the experimenters were ignorant (as ſome fear we yet are) of the true and firſt cauſes of magnetical phænomena, have produced inventions of greater uſe to mankind, than were ever made by *Leucippus*, or *Epicurus*, or *Ariſtotle*, or *Teleſius*, or *Campanella*, or perhaps any of the ſpeculative deviſers of new hypotheſes; whoſe contemplations aiming for the moſt part but at the ſolving, not the increaſing or applying, of the phænomena of nature, it is no wonder they have been more ingenious than fruitful, and have hitherto more delighted than otherwiſe benefitted mankind: I ſay hitherto, becauſe though experience warrants me ſo to ſpeak now, yet I am not unwilling to think, that hereafter, and perhaps

in

in no long time, when phyſiological theories ſhall be better eſtabliſhed, and built upon a more competent number of particulars, the deductions, that may be made from them, may free them from all imputation of barrenneſs. But of theſe things I otherwhere (though not, as I remember, in any of the following eſſays) more fully diſcourſe.

AND therefore I ſhall now reſume the ſubject, that occaſioned this long excurſion, and add to what I ſaid in excuſe of my venturing ſometimes to deliver ſomething as my opinion in difficult or controverted caſes, that I muſt declare to you, *Pyrophilus*, that as I deſire not my opinions ſhould have more weight with you, than the proofs brought to countenance them will give them; ſo you muſt not expect, that I ſhould think my ſelf obliged to adhere to them any longer, than thoſe conſiderations, that firſt made me embrace them, ſhall ſeem of greater moment, than any that I can meet with in oppoſition to them. For *Ariſtotle* ſpoke like a philoſopher, when to juſtify his diſſent from his maſter *Plato*, he ſaid, among other things, that for the ſake of truth, men (eſpecially being philoſophers) ought to overthrow even their own tenets (Δόξει δ' ἂν ἴσως βέλτιον εἶναι, καὶ δεῖν ἐπὶ σωτηρίᾳ γε τῆς ἀληθείας καὶ τὰ οἰκεῖα ἀναιρεῖν, ἄλλως τε καὶ φιλοσόφους ὄντας.) And though for a man to change his opinions, without ſeeing more reaſon to forſake them than he had to aſſent to them, be a cenſurable levity and inconſtancy of mind; yet to adhere to whatever he once took for truth, though by acceſſion of more light he diſcover it to be erroneous, is but a proud obſtinacy, very injurious to truth, and very ill becoming the ſenſe we ought to have of human frailties. And it ought to be eſteemed much leſs diſgraceful to quit an error for a truth, than to be guilty of the vanity and perverſeneſs of believing a thing ſtill, becauſe we once believed it. And certainly, till a man is ſure he is infallible, it is not fit for him to be unalterable.

Ethic. Nicom. l. 1. cap. 6.

YOU will eaſily diſcern, *Pyrophilus*, that I have purpoſely, in the enſuing eſſays, refrained from ſwelling my diſcourſes with ſolemn and elaborate confutations of other men's opinions, unleſs it be in ſome very few caſes, where I judged, that they might prove great impediments to the advancement of experimental learning; and even ſuch opinions I have been wary of meddling with, unleſs I ſuppoſed I could bring experimental objections againſt them. For it is none of my deſign to engage my ſelf with, or againſt, any one ſect of Naturaliſts, but barely to invite you to embrace or refuſe opinions, as they are conſonant to experiments, or clear reaſons deduced thence, or at leaſt analogous thereunto; without thinking it yet ſeaſonable to contend very earneſtly for thoſe other opinions, which ſeem not yet determinable by ſuch experiments or reaſons. And indeed, to allude to our former compariſon, I would endeavour to deſtroy thoſe curious but groundleſs ſtructures, that men have built up of opinions alone, by the ſame way (and with as little noiſe) by which ſuch fantaſtical ſtructures, as thoſe I mentioned to have ſeen at *Leyden*, may be demoliſhed. To deſtroy which, it were needleſs to bring battering engines, ſince nothing is requiſite to that effect but an increaſe of light. And experience has ſhown us, that divers very plauſible and radicated opinions, ſuch as that of the unhabitableneſs of the torrid zone, of the ſolidity of the celeſtial part of the world, of the blood's being conveyed from the heart by the veins (not the arteries) to the outward parts of the body, are generally grown out of requeſt, upon the appearing of thoſe new diſcoveries, with which they are inconſiſtent, and would have been abandoned by the generality of judicious perſons, though no man had made it his buſineſs, purpoſely, to write confutations of them: ſo true is that vulgar ſaying, that *Rectum eſt index ſui & obliqui.*

BUT when at any time, *Pyrophilus*, I have been induced to oppoſe others, as I have not denied my ſelf the freedom, that is requiſite unto loyalty to truth; ſo I have endeavoured to uſe that moderation, and civility, that is due to the perſons of deſerving men. And therefore you ſhall find me not only in one eſſay oppoſe an author, whom in another I applaud; but ſometimes you may find me commending a writer in the very ſame page, perhaps, where I am endeavouring to diſprove his opinions: for I love to ſpeak of perſons with civility, though of things with freedom. Nor do I think it reaſonable, either that any man's reputation ſhould protect his errors, or that the truth ſhould fare the worſe for his ſake, that delivers it. And as for the (very much too common) practice of many, who write, as if they thought railing at a man's perſon, or wrangling about his words, neceſſary to the confutation of his opinions; beſides that I think ſuch a quarrelſome and injurious way of writing does very much miſbecome both a philoſopher and a Chriſtian, methinks it is as unwiſe, as it is provoking. For if I civilly endeavour to reaſon a man out of his opinions, I make my ſelf but one work to do, namely, to convince his underſtanding; but, if in a bitter or exaſperating way I oppoſe his errors, I increaſe the difficulties I would ſurmount, and have as well his affections againſt me as his judgment: and it is very uneaſy to make a proſelyte of him, that is not only a diſſenter from us, but an enemy to us. And that which makes me the more diſlike the bitter way of diſputing, which I am reprehending, is, that I have often obſerved, that though one of the diſputants alone be at firſt in the fault, yet the other is moſt commonly drawn to ſhare in the guilt, though, to contract it, he muſt imitate his adverſary. For as a mad dog, by biting others, is wont to make thoſe he bites run mad like himſelf, and do promiſcuous miſchief; ſo theſe ſo provoking writers are wont to enrage thoſe they offend, and infect them alſo with their own virulent diſtemper. But, *Pyrophilus*, when I ſpeak of dealing reſpectfully with thoſe I diſſent from, I would be underſtood of ſuch, as have well deſerved of experimental learning, or at leaſt been candid and ſober inquirers after truth. For, as I think, that it would much diſcourage any prudent perſon from venturing to communicate

what

what he thinks he knows to the world, to find, that an error proceeding from human weakneſs, or the darkneſs and abſtruſity of things, ſeldom eſcapes being detected without being made matter of diſgrace or reproach to the author: ſo, on the other ſide, when vain writers, to get themſelves a name, have preſumed to obtrude upon the credulous world ſuch things, under the notion of experimental truths, or even great myſteries, as neither themſelves ever took the pains to make trial of, nor received from any credible perſons that profeſſed themſelves to have tried them; in ſuch caſes, I ſee not how we are obliged to treat writers, that took no pains to keep themſelves from miſtaking or deceiving, nay, that cared not how they abuſe us to win themſelves a name, with the ſame reſpect, that we owe to thoſe, who, though they have miſſed of the truth, believed they had found it, and both intended to deliver it, and took ſome (though not proſperous) pains, that they might convey nothing elſe to us.

I FEAR it will be requiſite, *Pyrophilus*, to tell you, why in ſome of the following eſſays you will meet with many paſſages tranſcribed out of other authors, and in ſome very few or none at all. And therefore to give you firſt a ſhort account of the particular mentioned laſt, I muſt mind you, that it was moſt ſuitable both to my humour and deſign, to deliver only thoſe things, wherewith my own obſervations, or trials, or thoughts, had furniſhed me, without troubling you with the repetition of thoſe things, which had been delivered by others already; thoſe kind of repetitions, unleſs they be made upon ſome ſuch grounds as we ſhall preſently mention, ſeeming to me to be as vainly as ambitiouſly affected by many writers, and being deſervedly troubleſome to judicious readers, who can eaſily diſcern, that they add much more to the bulk of books than of knowledge. But this notwithſtanding, *Pyrophilus*, I thought my ſelf obliged on ſome occaſions, for your ſake, to overcome my natural averſeneſs to ſtuff any writings of mine with paſſages tranſcribed from thoſe of others, partly for the reaſons elſewhere inſiſted on, and partly for divers others. As firſt, becauſe ſome particulars are of that ſtrangeneſs, and of that moment, that they need and deſerve to be verified by more than a ſingle atteſtation. Next, becauſe according to the Greek proverb, κοινὰ καινῶς, it is not properly to ſay over the ſame thing again, when the obſervation, experiment, or other paſſage of an author, is either illuſtrated, or otherwiſe improved by the repetition, or elſe applied to ſome purpoſe differing from that, to which the author brought it: that being applicable to many a ſingle experiment or obſervation, which *Seneca* ſomewhere ſays, *Nulla res conſummata eſt dum incipit*; and, *Etiamſi omnia à veteribus inventa ſunt, hoc ſemper novum erit, uſus, & inventorum ab aliis ſcientia & diſpoſitio.* And thirdly, becauſe as the planets and other ſtars have (according to aſtrologers) in their great ſynods or conjunctions, much more powerful, and ſometimes other influences on the air and ſome other ſublunary parts of the world, than are aſcribed to one or two of them out of that aſpect; ſo divers particulars, which whilſt they lay ſingle and ſcattered among the writings of ſeveral authors were inconſiderable, when they come to be laid together in order to the ſame deſign, may oftentimes prove highly uſeful to phyſiology in their conjunction, wherein one of them may ſerve to prove one part or circumſtance of an important truth, and another to explicate another, and ſo all of them may conſpire together to verify that ſaying, *Et quæ non proſunt ſingula, multa juvant.* It may then, I hope, ſuffice to juſtify me on this occaſion, that not appealing to other writers as to judges, but as to witneſſes, nor employing what I have found already publiſhed by them barely as ornaments to imbelliſh my writings, and much leſs as oracles by their authority to demonſtrate my opinions, but as certificates to atteſt matters of fact, I may hope, that their teſtimonies will as well be illuſtrated by mine, as mine by their's, and that all of them may contribute to your better information.

Quæſtion. Natural. lib. 6. cap. 5. *Epiſtola* 64.

AND if, *Pyrophilus*, you grant, that upon theſe conſiderations I have not done amiſs to apply to my purpoſe divers of thoſe things, which I found delivered pertinently to them by thoſe writers, which I chanced to caſt mine eyes on, I ſuppoſe you will not think I need to make you an apology, for my having made moſt uſe of the paſſages of thoſe writers, which I ſuppoſe will be moſt difficult to be met with (ſuch as are many books of navigation and other voyages) and eſpecially of French books not yet tranſlated into Engliſh or Latin. And I think I ſhall leſs need to make an excuſe for my having for the moſt part ſet down the paſſages I recited in the author's own words, that being one of the readieſt ways I know to ſatisfy the reader, and avoid injuring the writer. And indeed, I have met with abundance of quotations, wherein the tranſcriber doth ſo miſtake, or ſo miſ-repreſent the cited author's meaning, ſometimes out of inadvertence, but ſometimes too I fear out of indulgence to his own hypotheſis, that if ever I ſhould be tempted to trouble the world with any of my thoughts, I would beſeech my readers, not to look upon any thing as my opinion or aſſertion, that is not delivered in the intire ſeries of my own words; leſt a tranſcriber ſhould make me deliver thoſe things reſolutely and dogmatically, which I deliver but heſitantly and conjecturally; and leſt I ſhould ſeem to ſet down thoſe things poſitively as proceſſes, for whoſe ſucceſs I undertake, which I record but by way of narrative.

FOR my ſo frequently mentioning what I have borrowed from other writers, or received from my friends, I expect to be excuſed by that of *Pliny*, *Benignum eſt (ut arbitror) & plenum ingenui pudoris, confiteri per quos profeceris.* Though I have ſeen divers modern writers, that ſo boldly uſurp the obſervations and experiments of others, that I might juſtly apply to them what the ſame *Pliny* annexes; *Scito enim, conferentem authores me deprehendiſſe à juratiſſimis & proximis veteres tranſcriptos ad verbum neque nominatos, &c.* If other

writers ſhould not prove more equitable (for I will not ſay more thankful) than ſuch as theſe, they would quickly diſcourage thoſe, whoſe aims are not very noble and ſincere, from gratifying the publick with inventions, whoſe praiſe and thanks would be uſurped by ſuch as will not name them. But perhaps they would be more juſt, if they reflected on what our author further adds, *Obnoxii profectò animi & infelicis ingenii eſt, deprehendi in furto malle, quam mutuum reddere, cum præſertim ſors fiet ex uſura.*

AND now I have ſaid this concerning the paſſages I have borrowed from other authors, it will not be improper to add ſomething about thoſe I have declined to borrow. For you may poſſibly marvel, that in divers of the hiſtorical parts of my writings I have omitted ſuch teſtimonies either of *Pliny*, *Solinus*, *Ariſtotle*, *Theophraſtus*, *Ælian*, or, perchance, ſome of the antient phyſicians themſelves (who yet, as more converſant with things, are uſually more credible) as ſeem very pertinent to my diſcourſe, and fit to prove what I deſign. But when I ſhall come to entertain you about natural hiſtory, I doubt not but to ſatisfy you with the reaſons I ſhall offer you of this practice. In the mean time, I ſhall only tell you in ſhort, that though I have a juſt reſpect for thoſe great names I have mentioned; yet the ſenſe I have of the difficulties I have found to make and relate an obſervation accurately and faithfully enough for a naturaliſt to rely on; and the occaſions I have had of looking into divers matters of fact delivered in their writings, with a bold and impartial curioſity; have made me conclude ſo many of thoſe traditions to be either certainly falſe, or not certainly true, that except what they deliver upon their own particular knowledge, or with peculiar circumſtances, that may recommend them to my belief, I am very ſhy of building any thing of moment upon foundations, that I eſteem ſo unſure, and much leſs upon the ſuſpected paſſages, that *Wecker*, *Paracelſus*, *Porta*, &c. abound with. And therefore (though I well enough know, how much I impoveriſh my diſcourſe by this niceneſs) yet I do not think it fair to imploy that as an argument to convince you, that has not that operation upon me myſelf. And I rather take notice of my forbearing to make uſe of the hiſtorical traditions and chymical or magical ſecrets, that I meet in the above-mentioned authors, or any other makers of collections, unleſs the narrative be (as I was ſaying) expreſly enough delivered upon the writer's perſonal knowledge, or that of ſome other credible witneſs; not only becauſe I would give you an account, why ſeveral of my writings are unfurniſhed with what moſt readers look on as the richeſt ornaments of other men's; but becauſe if this warineſs could be introduced, it would be the moſt effectual way of perſuading men to write thoſe kind of tracts I would recommend, phyſiological eſſays. For he, that will confine himſelf ſo ſtrictly, will ſcarce be often tempted, on phyſical ſubjects, to write either ſyſtems or volumes.

ANOTHER thing, *Pyrophilus*, I muſt needs advertiſe you of in reference to the enſuing diſcourſes; which is, that beſides thoſe deficiencies in point of ratiocination, which are due to my perſonal diſabilities, I have purpoſely let paſs ſome few (and but very few) inferences, which I diſcerned well enough not to be cogent, becauſe I was willing to acquaint you upon ſome particular occaſions with all the experiments then occurring to me, which I thought might contribute to the illuſtration of the ſubject in hand; though each of them apart did not irrefragably, nor indeed ſo much as ſtrongly infer the concluſion, in order to which they ſeemed to have been mentioned as premiſſes. And this practice I made the leſs ſcruple of, becauſe I was willing to exerciſe thereby your reaſoning faculty, and try how far you would diſcern the tendency of ſeveral things, all of them pertinent enough to the ſubject in hand, but not all of them concluding to the main deſign, in order whereunto they were alledged. And I ſuppoſed, that the things by me mentioned, though not concluſive, being yet experimental, the mention of them, which in a ſtrictly logical way of reaſoning muſt have been forborn, might well make you amends for the exerciſe, to which I intended they ſhould put your reaſon.

THERE remains yet one thing, *Pyrophilus*, of which I ſuppoſe you will expect I ſhould give you an account; and that is, why in the enſuing eſſays I have mentioned divers experiments, which I have not plainly and circumſtantially enough delivered. To ſatisfy you concerning which, I muſt repreſent to you, firſt, that though for your ſake I have oftentimes, contrary to my reaſon and genius, delivered things, to make them more clear, in ſuch a multitude of words, that I now ſeem even to my ſelf to have in divers places been guilty of verboſity; yet in ſome other paſſages, treating of things, which uſe had rendered very familiar to me, I may have, to ſhun prolixity, unawares ſlipt into the contrary extreme. Secondly, there are ſome mechanical experiments, wherein I have purpoſely omitted ſome manual circumſtances, becauſe I was unwilling to prejudice ſome ingenious tradeſmen, who make either a livelihood, or at leaſt a gain, by the ſale of the productions of ſuch experiments. And I made the leſs ſcruple to conceal ſuch mechanical circumſtances, (if I may ſo call them) becauſe they were not neceſſary to the phiſiological knowledge of the experiments; in naming of which, my intention was to teach you rather philoſophy than trades. Thirdly, I mention ſome things but darkly, either becauſe I received them upon condition of ſecrecy, or becauſe ſome ingenious perſons, that communicated them to me, or others to whom I imparted them, do yet make, and need to make, a pecuniary advantage of them. Fourthly, And ſome things, that, either having been the fruits of my own labours, or obtained in exchange of ſuch, are freely at my own diſpoſal, I have not yet thought fit ſo plainly to reveal, not out of any envious deſign of having them buried with me, but that I may be

always provided with ſome rarity to barter with thoſe ſecretiſts, that will not part with one ſecret but in exchange for another, and think nothing worth their deſiring, that is known already to above one or two perſons. And I think it very lawful to reſerve always ſome concealed experiments by me, wherewith to obtain the ſecrets of others, which being thereby gained, the other (as being no longer neceſſary to the former end) may freely be communicated.

AND think not, *Pyrophilus*, that the bare mention of an experiment as having been perfomed, though the way of making it be concealed, is of no uſe, if the relator of the experiment be a perſon, that may ſafely be crecited: For it is ſomething, to be aſſured, that ſuch and ſuch things have been really performed, and conſequently are poſſible to be done, though we be not particularly acquainted with the means of performing them. And he tells you ſomething, that tells you upon his own knowledge, that in ſuch or ſuch bodies, or ways of operating on them, conſiderable things of ſuch or ſuch a nature are to be met with. And for my part, when I go a hawking or ſetting, I think my ſelf beholden to him, that aſſures me, that in ſuch a field there is a covey of partridges, though he does no more towards the giving me them. And it is obvious, how much *Europe* is beholden to *Columbus* for the detection of many countries in *America*, which were not diſcovered by him, nor perhaps till long after his death, becauſe he firſt informed us knowingly, that there were unknown regions beyond that vaſt ocean, which ſevers the old world from the new. But I begin to digreſs, and therefore ſhall proceed to tell you, that I am the leſs troubled at my omiſſion of the circumſtantial parts of ſome experiments, becauſe I think it will be much for your advantage to try them over again your ſelf. And as I have taken care by the truth of the experiments I have delivered, to ſecure your ſucceſs, in caſe you try them aright; ſo I cannot be very ſorry, that you ſhould in ſome particulars have a kind of neceſſity laid on you to exerciſe your own induſtry, and thereby increaſe your experience.

BUT beſides all that has been ſaid, *Pyrophilus*, I muſt freely confeſs to you, that there is one thing particularly relating to your ſelf, which has made me refrain from delivering, in the enſuing eſſays, ſome of the chief chymical proceſſes, wherewith they might have been enriched. For not yet knowing with what ſeriouſneſs you will addict your ſelf to promote experimental philoſophy, nor what uſe you will make of what has been unveiledly communicated to you, I was ſomewhat unwilling, that ſome things, which had coſt me a great deal of pains, ſhould yet fall into any man's hands, that ſcorns to purchaſe knowledge with ſome pains; and I was deſirous, in caſe you ſhall prove as induſtrious as I hope you will, to have ſomething by me to encourage and cheriſh your induſtry, which may be more ſuitable to your improved knowledge. For I muſt confeſs to you, that in reference to the chymical proceſſes extant in the following diſcourſes, I look upon moſt of them but as trifles, not only in compariſon of thoſe things, which a knowing chymiſt might have delivered on the ſame ſubjects, but even in regard of divers proceſſes (not impertinent to thoſe diſcourſes) wherewith I my ſelf, (as little as I am a pretender in theſe matters) am not unacquainted: and perhaps I would have given to the following treatiſes the title of trifles, inſtead of that of eſſays, if I had not been afraid of diſcouraging you thereby, and if the chymical part of them had been the chief thing, wherewith I intended to acquaint you in them. But if the reception you give to what we have already written, prove ſuch as may encourage us to proceed, we may perhaps, if God be pleaſed to vouchſafe us life and opportunity, be invited to impart to you thoſe more conſiderable chymical experiments, which either the communication of our friends, or our own labours, have preſented us. For it will be much in the power of the entertainment, which theſe papers ſhall meet with, to make them either the beginning of our labours of this nature, or the end. And in the mean time, I think I may venture to tell you, that, as inconſiderable as I have confeſſed divers of the chymical proceſſes mentioned in the eſſays to be, yet if ever you take the pains (as I hope you will) to write experimental eſſays, and confine your ſelf to take as little upon truſt as I have done, you will perhaps be ready to believe, that ſometimes a ſhort eſſay of this nature, not to ſay ſome one ſingle experiment, may have coſt me more than a whole treatiſe written on ſuch a ſubject, whereon to be able without diſcredit to write books, it is almoſt ſufficient to have read many. And give me leave to add, that as in ſuch kind of compoſures, oftentimes the enabling himſelf to give a conſiderable advertiſement, or even hint, may coſt the writer more than the making of ſeveral experiments; ſo it may be alſo more beneficial to the reader than the knowledge of them. For we muſt not always meaſure the conſiderableneſs of things by their moſt obvious and immediate uſefulneſs, but by their fitneſs to make or contribute to the diſcovery of things highly uſeful. As, if it be true, what is reported by good authors of the hazel wand, or *virgula divinatoria*, though the hazel tree be much leſs conſiderable in reference to its fruit, or immediate productions, than a peach-tree, an orange-tree, or even an apple-tree; yet may it be made much more valuable than any of them, becauſe, whereas they only preſent us with fruits, this may aſſiſt us to diſcover in latent mines ineſtimable treaſures.

I had almoſt forgot to advertiſe you, *Pyrophylus*, that whereas I have not been ſo ſollicitous as moſt writers are wont to be, to ſwell the enſuing eſſays with the enumeration of the various opinions and arguments of authors about the ſubject I treat of, or to adorn them with acute ſentences, fine expreſſions, or other embelliſhments borrowed from eminent writers; it has not been, becauſe I utterly diſlike the making uſe of thoſe paſſages in claſſick or other authors, that may either

give

give (among the admirers of thoſe writers) ſome authority to our thoughts, or very handſomely and emphatically expreſs them. For I remember, I have known it reprehended by learned men in *Epicurus*, that though he wrote very much himſelf, he would not vouchſafe in his writings to quote thoſe of other men. And that I have not refrained from making uſe, now and then, of thoſe philological ornaments of diſcourſe, when they readily occurred to me, and appeared neither impertinent nor prolix, may, I hope, ſuffice to keep me from being ſuſpected of the vanity of thinking my ſelf above other men's aſſiſtance. But the reaſons of my ſo much declining to make uſe of other men's authority, or expreſſions, were chiefly theſe: firſt, That the weakneſs of my eyes has this long time kept me from reading almoſt any books, ſave the Scripture, with ſome critical expoſitions of it, and, here and there, ſome portions of the writings of thoſe that pretend to teach their readers experimental matters: and the unfaithfulneſs of my memory, as to things of no great moment, has made me forget almoſt all the little philological and florid learning I was formerly acquainted with. And really, *Pyrophilus*, as for the books, that treat of natural philoſophy, I am ſo ſenſible of the ſmallneſs of the advantage, which my diſabilities have ſuffered me to make of them, that inſtead of being ambitious to appear a great reader, I could be very well content to be thought to have ſcarce looked upon any other book than that of nature. And in the next place, *Pyrophilus*, though I ignore not, that by this plain and unadorned way of writing, I unkindly deny my eſſays many imbelliſhments, which I might give them, and which perhaps you will think they do abundantly need; yet my frequent diſtempers, journeys, and other avocations, not allowing me ſo much time as I deſired, entertain you on philoſophical ſubjects, I thought it more requiſite to ſpend thoſe confined hours in acquainting you with my own thoughts, ſuch as they are, than with thoſe of other men; unleſs (as I formerly intimated) I can ſome way or other more than barely recite what I recite of theirs. And you will eaſily pardon me the injury, which for your ſake I do my own reputation by this naked way of writing, if you, as well as I, think thoſe the profitableſt writers, or, at leaſt, the kindeſt to their peruſers, who take not ſo much care to appear knowing men themſelves, as to make their readers ſuch.

TWO

ESSAYS,

Concerning the

Unſucceſsfulneſs of EXPERIMENTS,

Containing divers Admonitions and Obſervations (chiefly Chymical) touching that SUBJECT.

Advertiſement about the two following Eſſays.

THE author of theſe diſcourſes had enlarged them, in this ſecond edition, with divers obſervations and experiments, but that he has made uſe of them already in other papers belonging to his Sceptical or doubting Naturaliſt.

The Firſt ESSAY,

Of the Unſucceſsfulneſs of EXPERIMENTS.

I AM very ſorry, *Pyrophilus*, that to the many (elſewhere enumerated) difficulties which you may meet with, and muſt therefore ſurmount, in the ſerious and effectual proſecution of experimental philoſophy, I muſt add one diſcouragement more, which will perhaps as much ſurprize you as diſhearten you; and it is, that beſides that you will find (as we elſewhere mention) many of the experiments publiſhed by authors, or related to you by the perſons you converſe with, falſe or unſucceſsful, (beſides this, I ſay) you will meet with ſeveral obſervations and experiments, which, though communicated for true by candid authors or undiſtruſted eye-witneſſes, or perhaps recommended to you by your own experience, may upon

upon further trial, diſappoint your expectation, either not at all ſucceeding conſtantly, or at leaſt varying much from what you expected.

THIS advertiſement may ſeem of ſo diſcouraging a nature, that I ſhould much ſcruple the giving it you, but that I ſuppoſe the trouble at that unſucceſsfulneſs, which you may meet with in experiments, may be ſomewhat leſſened by your being forewarned of ſuch contingencies: and that if you ſhould have the luck to make an experiment once, without being able to perform the ſame thing again, you might be apt to look upon ſuch diſappointments as the effects of an unfriendlineſs in nature or fortune to your particular attempts, as proceed but from a ſecret contingency incident to ſome experiments, by whomſoever they be tried.

BUT becauſe, *Pyrophilus*, the advertiſement, which I am about to give you, may ſeem, as paradoxical, ſo diſcouraging; it will be but reaſonable, that I preſent you with ſome inſtances of the requiſiteneſs of it: which I ſhall the more willingly do, becauſe thereby I may not only evince the truth of it, but ſomewhat leſſen the deſpondency it is apt to produce, by letting you ſee, that though ſome of your experiments ſhould not always prove conſtant, you have divers partners in that infelicity, who have not been diſcouraged by it.

TO make nice and curious diſtinctions of the ſeveral grounds and occaſions of the unſucceſsfulneſs of experiments, would, perhaps, prove a work of greater difficulty than uſe; and therefore I ſhall content my ſelf groſly to diſtinguiſh the cauſes of that unſucceſsfulneſs, into the particular or miſtaken properties of the materials imployed about them, and ſome ſuch error committed in the handling of theſe materials, as though it hinder the ſucceſs of the experiment, is not eaſy to be diſcerned. Which therefore I mention, that I may diſtinguiſh theſe kind of errors, that I am now to conſider, from thoſe more obvious ones, which proceeding barely from the unſkilfulneſs of the tryers of the experiments, may be eaſily enough diſcerned, and either rectified or avoided by a knowing artiſt, or a perſon well verſed and expert in making thoſe particular experiments, which through that unſkilfulneſs may have miſcarried.

THE materials to be employed about the experiments we are conſidering may alſo admit of ſeveral diſtinctions; as into natural and factitious, ſincere and adulterate, ſimple and compound, *&c.* But we ſhall likewiſe purpoſely forbear the inſiſting on any of theſe, and content our ſelves to caſt what we have to ſay on this part of our theme, into a few and comprehenſive obſervations.

AND in the firſt place we will obſerve, that divers experiments ſucceeded not, becauſe they were at one time tried with genuine materials, and at another time with ſophiſticated ones: and in this caſe it may be all one, as to the event of the experiment, whether the materials, wherewith it was ſucceſsfully tried, were ſophiſticated or not, if thoſe made uſe of in the latter trial were of differing qualities from thoſe employed in the former; becauſe it may very well happen, that ſophiſticated bodies (as we may have occaſion to ſhew hereafter) by the addition of thoſe things, or by that deceitful way of preparation, whereby they have been ſophiſticated, may acquire an aptitude to produce ſuch effects, as, had they not been adulterated, they would not have been fit to do. Now it is ſcarcely imaginable to him, that has not been very converſant with the drugs and ſimples ſold in ſhops, how generally they are adulterated by the fraudulent avarice of the ſellers, eſpecially if they be ſuch, whoſe precioufneſs may make their ſophiſtication very beneficial to them, that practiſe it. It has been lately much complained of by ſome of the cultivators of clover-graſs, that of a great quantity of the ſeed not any graſs ſprung up; which not being imputable to the ſoil, nor the ſower, proceeds, as ſome analogical obſervations make me ſuppoſe, from the effeteneſs (if I may ſo ſpeak) of the ſuperannuated ſeed ſometimes ſold in the ſhops. And upon this ſubject I cannot conceal from you what was lately affirmed to me by one of the eminenteſt and ſobereſt chymiſts of *Amſterdam*, who was alſo an Indian merchant, who aſſured me, that the moſt of the cinnamon and cloves, that is brought into theſe weſtern regions, is defrauded in the *Indies* of much of the fineſt and ſubtileſt aromatical parts, before it be ſent into *Europe*. And to give a more familiar inſtance to our preſent purpoſe, you may be pleaſed to remember, *Pyrophilus*, that in one of the firſt of theſe eſſays, we have made mention to you of great ſtore of living creatures, which we had obſerved in vinegar; of the truth of which obſervation we can produce divers learned and ſevere witneſſes, who were not to be convinced of it, till we had fully ſatisfied them by ocular demonſtration: and yet, *Pyrophilus*, there are divers parcels of excellent vinegar, wherein you may in vain ſeek for theſe living creatures: and we are now diſtilling ſome of that liquor (which if we did not think to be of the ſtrongeſt and beſt ſort, we ſhould ſcarce think worth the being diſtilled for ſpirit) wherein nevertheleſs we can neither by candle-light nor by day-light diſcern any of thoſe little creatures, of which we have often ſeen ſwarms in other vinegars. Of ſuch fraudulent tricks as thoſe lately mentioned, I could eaſily give you divers inſtances, if I were not afraid of teaching fallacies by diſcovering them. But ſome are ſo notorious, or otherwiſe of ſuch a nature, as that it may be more uſeful than dangerous to mention them.

IT is commonly known, that ſublimate is wont to be ſophiſticated with arſnick: and how differing the effects of ſuch ſublimate may be from thoſe of that, which is faithfully prepared, not only upon metals, but (when mercurius dulcis and other preparations are made of it) upon human bodies, they, and ſcarce any but they, who are acquainted with the noxious qualities of arſnick, both to metals and men, can readily imagine. And indeed as for chymical preparations, *Helmont* * was not much in

* *Accipe pulverem* Joannis de Vigo *propria manu paratam, nam alioquin admiſtus minio eſt adulteratus, prout qualcunque medicamen chymicum quod venale exſtat fraude plenum eſt* Helmon. de Febr. c. 14.
Sunt nempe olea eſſentialia venalia, quæque magno ære penduntur, adulterata omnia atque ſinguli, &c. Idem de Feb. c. 15.

the wrong, when he affirmed, there were ſcarce any, vulgarly ſold in ſhops, to be relied on as faithfully prepared. And for my part, I have ſo often met with chymical preparations, which I have found unſincere, that I dare ſcarce truſt any, either in the adminiſtration of phyſick, or ſo much as in the trial of conſiderable experiments, which either my own furnaces do not afford me, or wherewith I am not ſupplied by ſome perſon, of whoſe ſkill and faithfulneſs I have a good opinion. The other day, having occaſion to uſe ſome ſpirit of ſalt, whereof I was not then provided, I ſent for ſome to a chymiſt, who making it himſelf, was the likelier to afford that, which was well made: but though I gave him his own rate for it, at the firſt rectification even in a retort, a ſingle pound afforded us no leſs than ſix ounces of phlegm; and afterwards being further rectified in a high body and gentle heat, the remaining ſpirit parted with a ſcarce credible quantity of the like nauſeous liquor, and after all theſe ſequeſtrations of phlegm, was not pure enough, to perform what we expected from it. Of which complaining to an excellent chymiſt of my acquaintance, he ſent for ſpirit of ſalt to a very eminent diſtiller of it, who gets much by his profeſſion, and paſſeth for a very honeſt man: but this ſpirit, beſides its weakneſs, diſcovered itſelf to be ſophiſticated with either ſpirit of nitre, or aqua fortis, which betrayed itſelf by its peculiar and odious ſmell; whereas ſpirit of ſalt ſkilfully and ſincerely drawn is commonly of a greeniſh colour, bordering upon yellow, and hath uſually a peculiar, and ſometimes (as I can exemplify to you in ſome of mine) a not unpleaſing ſmell. And let me on this occaſion advertiſe you, *Pyrophilus*, that in divers caſes it is not enough to ſeparate the aqueous parts by dephlegmation, as many chymiſts content themſelves to do; but ſome liquors contain alſo an unſuſpected quantity of ſmall corpuſcles of ſomewhat an earthy nature, which being aſſociated with the ſaline ones, do clog or blunt them, and thereby weaken their activity: and therefore ſuch liquors to be well depurated require the being diſtilled off, and that with a ſlow fire, that the dry fæces may be left behind in the bottom of the glaſs. To ſatisfy ſome perſons, that this obſervation is not groundleſs, we have ſometimes taken of the better ſort of ſpirit of ſalt, and having carefully dephlegmed it, removed it into lower glaſſes, (that the leſs heat will ſuffice to make the liquor aſcend) and having gently abſtracted the whole ſpirit, there remained in the bottom and the neck of the retort, whence it was diſtilled, ſo great a quantity of a certain dry and ſtiptical ſubſtance, for the moſt part of a yellowiſh colour, that it ſeemed ſtrange to the beholders, that ſo clear a ſpirit ſhould conceal ſo much of it: and we ourſelves ſhould have wondered at it too, had we not remembered, that in what the chymiſts are wont to call the oil or rectified butter of antimony made with ſublimate, the liquor, though diſtilled and very limpid, almoſt like fair water, conſiſts in great part of the very body of the antimony: which we would here manifeſt, but that we elſewhere do it; and therefore chuſe rather in this place to take notice, that the ſpirit of ſalt after this ſecond depuration was ſo changed, that it ſeemed to be a much nobler, and almoſt another liquor than it was before.

But to return to our ſophiſticated ſpirit; what differing effects would be produced by true ſpirit of ſalt, and that which is mixt with the ſpirit of nitre, he, that knows the great diſparity in the operations of thoſe two liquors, whereof (to mention now no other inſtances) the former will precipitate ſilver, when the latter has diſſolved it, may eaſily inform you. Which inſtances I mention not as the conſiderableſt, which may be produced on this ſubject, but as the freſheſt in my memory.

In the next place, *Pyrophilus*, I obſerve, that even when the materials imployed about experiments are no way ſophiſticated, but genuine, and ſuch as nature has produced them, or art ought to prepare them; even then, I ſay, there may be a very conſiderable diſparity betwixt concretions of the ſame kind and name, and which paſs without ſuſpicion for bodies of perfectly the ſame nature.

This may, to you, *Pyrophilus*, ſeem a great paradox; but perhaps upon examination it will appear a great truth: which becauſe I am, perchance, the firſt, that has ſolemnly aſſerted, I hope I ſhall obtain your pardon, if I inſiſt ſomewhat the longer upon the making it out. For though antimony (and the like is to be underſtood of quickſilver, gold, copper, tin, *&c.*) is wont by almoſt all men without heſitancy to be looked upon as being all of it of the ſame nature as well as denomination; yet he, that will take the liberty to ſuſpect, that they may be deceived in that opinion, and then heedfully obſerve the differing progreſs and event of experiments, may very well diſcern, that there is as well a difference in minerals of the ſame kind, as there is in vegetables and animals of the ſame ſpecies. And as the white roſe, the red roſe, and the damaſk roſe differ much from one another, though all three be roſes; and as the ſour and ſweet orange are very differing betwixt themſelves, and yet both of them from the *China* orange, though all be oranges; and as the hound, the grey-hound, the ſpaniel, the tumbler, the maſtiff, and the water-dog, *&c.* are very diverſly qualified, though all of them be dogs: ſo neither are all the parcels of antimony to be met with in mines or ſhops of altogether the ſame qualities, though all of them be antimonial concretes. There is indeed this difference betwixt the variety to be obſerved in vegetables and animals, and that which is to be found in minerals, that the former is wont to be more obvious to the eye, and betray itſelf by ſome difference to be obſerved, either in the ſize of creatures of the ſame kind, or in ſome peculiar ſhape or colour, by which it is eaſy for nature conſpicuouſly to diſcriminate bodies, that conſiſt of many diſcernably diſtinct parts; whereas minerals appearing to the eye either to be perfectly ſimilar, as metals, or at leaſt to conſiſt but of two or three diſtinct ingredients, as cinnabar, and ſome other mineral concretions, the diverſity to be found

found betwixt minerals of the ſame denomination is hardly to be diſcerned, before experience have diſcovered it.

AND on this ſubject I conſider, that the womb (if I may ſo ſpeak) of a mineral body is not always like that of an animal, a place by a competent and peculiar involving fence ſecured from the intruſion of all bodies not of kin to that included in it: but a mineral being generated in the bowels of the earth, its womb is oftentimes acceſſible and open to other mineral juices or ſteams, that paſs that way, though of never ſo differing natures from that of the more copious mineral. Inſomuch that not only I have had the opportunity to obſerve (not without ſome wonder) minerals of differing kinds, as marchaſites and metals; marchaſites and ſtones, (I mean ſtones properly ſo called) ſalt and ſulphur, and the like, blended in the ſame ſmall lump of matter; but I have ſometimes found, in a great maſs of one ſort of mineral, ſmall parcels of a mineral of a quite differing kind perfectly incloſed in the ſubſtance of the other. But to reſume what we were ſaying before, theſe intruding bodies (if I may ſo ſpeak) being coagulated, and perhaps ripened together with the former by length of time, are not eaſily either ſeparable, or ſo much as diſtinguiſhable at their firſt digging out of the ground, and much leſs after their coliquation. For the ignorant or heedleſs mine-man aiming only at the obtaining a quantity of ſuch a metal, or other mineral, as may be vendible under ſuch a determinate name, has neither the deſign, nor perhaps the ſkill, to make nice ſeparations of the heterogeneous bodies to be met with in his ore, but melts ſo much of them as he can promiſcuouſly together; and then ſells them, not only to the merchant, but the chymiſt, for that metal or mineral, whoſe outward form and properties (as colour, conſiſtence, weight, ſound, *&c.*) it has: though that metal, under whoſe name it paſſes, be indeed but the predominant ingredient of the lump, wherein divers other minerals may in ſmall quantities lie concealed, and yet upon occaſion be diſcovered by exquiſite ſeparations, or diſcover themſelves by unexpected operations, when they meet with bodies fit to act on them, or diſpoſed to receive impreſſions from them.

I WAS lately viſited by an ingenuous goldſmith of my acquaintance, who complained to me, that being wont to buy parcels of gold brought in ſmall pieces, and as it were ſandy corpuſcles, from *Guinea*, or ſome country of that coaſt, though he found it upon all trials very right gold, yet was it ſo very pale, that few but expert goldſmiths would meddle with it, as fearing it had been ſome ſophiſticated metal; adding, that this exceeding paleneſs of it ſometimes reduced him to melt it with very high-coloured gold, or to heighten its tincture with that of copper, to bring it to the colour of ordinary gold.

THE probability of this may be proved by what is related by Monſieur *Flacourt*, governour of the French plantation in *Madagaſcar*, who, in his newly publiſhed hiſtory of that iſland, ſpeaking of the metals of it, ſays, *Il y a bien*, &c. that is, there is certainly gold among the inhabitants of *Madagaſcar*, which has not been brought hither by foreign ſhips: for it is not poſſible, that ſuch ſhips ſhould have left them ſo much of that metal as they have; and beſides, it is of a differing nature from that of Europe, which they call in this country *Voulamene Voutroüa*. He adds, that this gold, which they call gold of *Malacaſſe*, is pale, and is not worth above ten crowns, (or about fifty ſhillings) an ounce; alſo, that the Negroes affirm, that there are many mines of it in the country, where it was formerly digged; that there is three ſorts of it differing in fineneſs from each other, and diſcriminated by the natives by three peculiar names. But that which he adds as moſt conſiderable, is, *that Malacaſſean gold is of ſo very eaſy a fuſion, that it is almoſt as eaſily melted as lead*; whereas we here find the gold we deal with to require conſiderably ſtrong fires, and are wont to caſt in borax to facilitate the fuſion. *Hiſtoire de Madagaſcar, c.* 37.

HAVING, upon occaſion, had the curioſity not long ſince to viſit ſome mines of lead, and other metals, I find, that there is a great difference, and diſcernible even to the eye, betwixt the ſeveral ores; for inſtance, of lead, ſome of which I can ſhew you ſo like ſteel, and ſo unlike common lead-ore, that the workmen upon that account are pleaſed to call it ſteel-ore, which being of more difficult fuſion than ordinary, they are wont to mix it with other ore, which they call firm-ore, to facilitate the melting of it. And I likewiſe took notice of an ore, which for its aptneſs to vitrify, and ſerve the potters to glaze their earthen veſſels, the miners call pottern-ore, and ſell it (at leaſt where I ſaw it digged up) dearer than other ore, from which it differs both viſibly enough, and as the workmen affirm, in divers other (and thoſe leſs obvious) qualities; and yet all theſe ores, after fuſion, do paſs indiſcriminately under the name and notion of lead. In which therefore it is no wonder, that ſeverer inquirers find a great deal of diſparity. I remember I did not long ſince cauſe ſome lead-ore to be tried, which being the moſt promiſing that ever I ſaw, made me ſuppoſe it might contain ſome conſiderable quantity of ſilver: but though it proved ſo rich in lead, as to yield after the rate of ſeventy pound in the hundred, yet one of the moſt expert artiſts in Europe could not extract one grain of ſilver out of it; whereas the lead of very many mines, being ſkilfully examined, will leave behind it, upon the teſt, a proportion of purer ſilver. And though this quantity of ſilver be not conſiderable enough to make ſuch mines as yield it paſs for ſilver-mines, (or, as we are wont to call them, mines-royal) becauſe the ſilver will not quit the coſt of extracting it; yet ſuch mines, though they paſs but for lead-mines with the metaliſt, may appear to be mixt mines to the naturaliſt, who may meet with divers experiments, wherein the little ſilver, that is in them, may make their lead operate differently from that of thoſe ores, which are wholly deſtitute of ſilver.

AND as this diſparity is diſcernible in lead-ores,

ores, ſo it may well be ſuppoſed, that the like would be diſcovered in the ores of other metals, if they were but purpoſely and ſkilfully examined. On which ſubject I remember, that a very experienced perſon in theſe affairs, and otherwiſe very candid and ſober, was lately very deſirous I ſhould procure him ſome tin-ore, alledging, that he had met with a ſort of it, which, after a long digeſtion in lixiviate liquors, afforded him a very conſiderable proportion of the richer metals; inſomuch that having a large quantity of that ore, and finding the experiment on it to ſucceed conſtantly, he promiſed to himſelf a vaſt income by it: but when that ſtock of ore was ſpent, the next that he procured, though with great carefulneſs managed as the former, would by no menns be brought to afford either ſo conſiderable a benefit, or ſo much as any at all. Which brings into my mind, that having once bought a parcel of block-tin, (as the tradeſmen call that, which is of the moſt pure or unmixt, and as yet unwrought) I was deſirous to try, if I could not make a menſtruum to diſſolve it in ſuch manner as aqua fortis diſſolves ſilver, and aqua regis gold; becauſe chymiſts are wont to complain, that though they have a menſtruum or two that will diſſolve crude tin, yet they want one, that will keep it diſſolved, and will not, which aqua fortis will, let it fall into a calx. Having therefore (by a way that I elſewhere teach) prepared ſuch a liquor as was deſired, I evaporated a ſolution of the fore-mentioned tin, and ſetting it to ſhoot, found ſomewhat, to my wonder, that the cryſtals it afforded were not at all like any kind of vitriol, but broad, flat, and exceeding thin, juſt like thoſe of ſilver. Whereupon for further trial, having examined this ſalt by the tongue, we found not, that it had any ſuch taſte as ſkilfully made calx of tin in ſpirit of vinegar, (wherein it is not every calx of *Jupiter* that is ſoluble) which (the laſt time we tried) ſeemed to us to have, as it were, a chalybeate taſte, but ſuch an exceſſive bitterneſs as may be met with in the cryſtals of ſilver made with aqua fortis. Finding alſo this further reſemblance betwixt the ſalts of theſe two metals, that they did both of them preſently dye upon the nails and ſkin a blackneſs, that could not in a ſhort time be waſhed off; we ſhould have ſuſpected, that the menſtruum had exalted the metal diſſolved in it to a greater cognation to ſilver; but having afterwards proſecuted the ſame trial with the ſame menſtruum, and another parcel of block-tin, (the former being caſually loſt) this metal, though bought very ſoon after the other, and, as I remember, at the ſame place, made us conclude, that the event of our trials proceeded from our having lighted upon a lump of tin, that was of a peculiar nature.

I Remember alſo, that a while ſince a learned and inquiſitive friend of mine found in his land a parcel of ore, part of which he ſhewed me, and ſome of which I can ſhew you, but have not yet made trial of it; which ſeemed to me, among others that looked upon it, to be copper ore, and which did indeed, after fuſion, yield very good copper; but the perſons, to whom he committed the examination of the mine, being very inquiſitive, and extraordinarily ſkillful, they did (as one of themſelves immediately after confeſſed to me) find in that ore, beſides the copper, no inconſiderable quantity of ſilver; and in that ſilver (having diſſolved it in aqua fortis) a conſiderable proportion of gold.

But to detain you no longer on this ſubject, give me only leave to ſtrenghen the paradox I have propoſed, by the authority of that great and candid chymiſt *Baſilius Valentinus*, who ſpeaking of antimony, after he hath told us, that there are ſeveral kinds of it, and eſpecially two; the one more mercurial, and of a golden property, witneſſed by the ſhining ſtreaks or beams it abounds with; the other more full of ſulphur, but deſtitute of the golden nature that inriches the former; adds, that there is ſuch a different goodneſs betwixt the ſeveral ſorts of antimony, as there is betwixt the ſeveral ſorts of fleſh or fiſh, which, though agreeing in name, and, if you pleaſe, in nature, do exceedingly differ in point of goodneſs. Which brings into my mind the great difference, which I have found, even viſible to the eye, betwixt the ſeveral ſorts of antimony; and makes me alſo remember, that the other day being by an excellent chymiſt ſhewed a parcel of antimony as a rarity, upon the ſcore of the various-coloured ſulphur, wherewith it was conſpicuouſly inriched, the poſſeſſor of it ſoon after imployed it to make butter of antimony: but though he were very expert in that kind of diſtillation, yet inſtead of the liquor he expected, upon the approach of a gentle fire, he found the neck and body of his retort lined with an antimonial cinnabar, (or at leaſt a red ſubſtance, by him concluded to be ſulphur;) at which being ſurprized, he was pleaſed to withdraw his fire, till he had acquainted me with this accident, and in the yet unbroken retort ſhewed me the cinnabar, which is not wont (as you know) to ariſe till after the butter of antimony is come over, and the remaining matter be urged with a vehement fire. And it is perhaps to the undiſcerned difference of antimonies, that we may ſometimes aſcribe that contingency, which we have divers times had occaſion to take notice of in the making of antimonial cinnabar: for though in our furnaces it hath been very ſucceſsfully made, yet not only we have afterwards failed of making it, but we have ſeen much more expert chymiſts, and who, becauſe of the high value they do (not undeſervedly) place upon that medicine, imploy themſelves oftener than we in making it, divers times unſucceſsfully attempt the preparing it. And it may be perhaps alſo from ſome diverſity either in antimonies or irons, that eminent chymiſts have (as we have obſerved) often failed in their endeavours to make the ſtarry regulus of *Mars* and antimony. Inſomuch that divers artiſts fondly believe and teach (what our experience will not permit us to allow) that there is a certain reſpect to times and conſtellations requiſite to the producing of this (I confeſs admirable) body. Upon which ſubject I muſt not omit

omit to tell you, that a while ſince an induſtrious acquaintance of ours was working on an antimony, which unawares to him was, as we then ſuppoſed, of ſo peculiar a nature, that making a regulus of it alone (without iron) the common way, (for his manner of operation I inquired of him) he found, to his wonder, and ſhewed me his regulus adorned with a more conſpicuous ſtar, than I have ſeen in ſeveral ſtellate regulus's of both antimony and *Mars*. Yet I dare not be too confident that this depended only upon the peculiar nature of that antimony, becauſe ſince that, my own laboratory has afforded me divers ſuch parcels of regulus without *Mars*, (ſome of which I have yet by me very fairly ſtellated) which though made of antimony, that ſeemed (by its various colours) to be more rich than ordinary in ſulphur; yet in regard the antimony did not conſtantly afford a ſtarry regulus, though by the ſame perſon ordered as near as could be after the ſame manner, it did not ſo clearly appear to me, whether the different event of the ſeveral trials proceeded from the peculiar nature of this or that parcel of antimony, or from ſome odd and ſcarce diſcoverable circumſtance in the management of the operation. But in either caſe, the mention of theſe uncertain events will properly enough belong to our preſent diſcourſe.

As in antimony, ſo (as I intimated above) in divers other minerals a conſiderable diverſity may be obſerved: and I remember I was lately preſented with a piece of a mineral, which to me, as well as to the reſt who looked on it, ſeemed to be an ordinary and worthleſs marchaſite; and yet a Dutch merchant (a ſkilful mineraliſt) who was the poſſeſſor of it, was very induſtrious to procure a greater quantity thereof, having in ſome of it, on which he had made trials, found a rich proportion of pure gold. And the ſame gentleman, whoſe copper-ore I formerly mentioned, digging for more of that ore, found lately a quantity of red earth, which by knowing mineraliſts was gueſſed to be but bolus, and indeed looked very like it; but being melted with *regulus Martis ſtellatus* by a ſkilful trier of metals, it divers times richly recompenſed the examiner's curioſity, by affording him many grains of fine gold: and though I doubt, whether this gold proceeded from the bolus, or the regulus melted with it, yet however it may ſerve for an inſtance to ſhew, that ſome mineral bodies, which paſs without diſpute for minerals of ſuch and ſuch a preciſe nature, may have lurking in them minerals of a quite other nature, which may manifeſt themſelves in ſome particular experiments, (wherein they meet with proportionate agents or patients) though not in others.

THAT the talc, which is wont to be employed about coſmeticks, is of very difficult calcination, is ſo known a thing to thoſe, that have tried to calcine it, that I have met with good chymiſts, that have looked on all the calces of talcs but as impoſtures, Nor indeed have we calcined Venetian talc without ſome length of time, and much violence of heat. But among many ſorts of talc we have here in *England*, there is none, which a moderate fire will in leſs than an hour reduce into a ſnow-white calx, of which I had lately a parcel by me; and ſome days ſince I met with another ſort of Engliſh talc which I could ſuddenly calcine even with the flame of a candle. And my experienced friend Dr. *K.* aſſures me, that out of a German talc he met with, he did by digeſting it in a ſtrong ſolution of alcalizate ſalts ſeparate pretty ſtore of good gold, and might have made it a very gainful experiment, if all the talc growing in the ſame place had been of the ſame richneſs. The like almoſt has been affirmed to me by a gentleman of eminency, who told me, that from a certain talc he had out of *Norway*, he had once drawn a pretty quantity of very good gold: and it ſeems indeed, that though ſome have been pleaſed to laugh at all attempts of ſequeſtring any thing from any kind of talc; yet ſome parcels of that mineral afford good ſtore of a tincture, which may, for aught I know, be of a golden nature. For I remember I have met with a kind of darkiſh-coloured talc (whereof I can yet ſhew you a piece) which when I caſt but into aqua regis, the menſtruum manifeſtly worked upon it, and diſſolved its coloured parts in ſuch plenty, that the filtrated ſolution paſſed without ſuſpicion among divers knowing naturaliſts, to whom I ſhewed it, for a fair ſolution of gold. *Paracelſus* himſelf reckons four kinds of talck, red, white, black, and of that colour, which his interpreter tranſlates luteous: and perhaps each of theſe colours compriſes ſeveral kinds of that mineral. And therefore that mineraliſt did not amiſs, when he added in the ſame diſcourſe, after he had mentioned great variety of marchaſites, ſtones, and other minerals, *Sed & hoc verum eſt, in terra multa adhuc condi, quæ mihi incognita ſunt, ſed eadem nec alii norunt. Certum ſiquidem eſt, progreſſu temporis tot tumque varia à Deo adhuc proditum iri, de quibus nemo noſtrûm nedum unquam ſomniavit.*

Paracel. *de Mineral. Tract.* 1.

Paracel. *ibidem.*

IT is vulgarly known, that there is a great difference between vitriols, that are reputed to be meerly of the ſame metal. And not to mention thoſe vitriols, that I have either made or ſeen, of leſs uſual colours; nor to take notice of the veins, ſlate, and even looſe earth, impregnated with copperas that I have had: to paſs by all this (I ſay) as for thoſe vitriol ſtones, whereof we in *England* are wont to make our vitriol, I have ſeen, at the chief work where copperas is made, ſo great a variety of them, (divers of which I have yet lying by me) that I could ſcarcely believe the workmen, when they affirmed them to be all copperas ſtones; and cannot but think it both very likely, that ſome of them contain other mineral ſubſtances beſides vitriol, and very poſſible, that the ſaline parts of thoſe ſtones, upon their ſolution by the rain, may work upon thoſe other ſubſtances formerly concoagulated with them, and thereby imbue ſome parcels of the vitriol made of them with qualities other than are eſſential to the nature of vitriol, or belong ordinarily to it.

THAT there is alſo a difference betwixt thoſe bodies, that paſs under the general name of

common ſalt, cannot but be obvious to any chymiſt, that hath occaſion to make accurate trials on that ſubject. And as for thoſe concretes, that paſs under the name of ſalt-petre, there is probably no ſmall diſparity among them: for beſides the difference, which we have obſerved, and which is obvious enough betwixt good Engliſh nitre, and that which is brought us over from *Barbary*, (which before it is much refined abounds very much with an adventitious ſalt, that taſtes much like ſea-ſalt) beſides this I ſay, thoſe that do uſe both good European and good Eaſt-Indian ſalt-petre aſſure me, they find much difference betwixt them, and give the preference to the latter. And indeed I have often thought I diſcerned a conſiderable difference in the operations of ſeveral kinds of ſalt-petre even after purification: and probably that ſort of ſalt-petre, which near *London* an ingenious man of my acquaintance does ſometimes (but cannot always) make, chiefly out of ſea-ſalt, hath ſome differing qualities from that, which is drawn the common way out of the earth. And indeed ſalt-petre being but a kind of ſal terræ, generated in very differingly-qualified parcels of earth, may probably receive divers qualities from the particular ſoil, wherein it grows, though theſe qualities lie concealed and unſuſpected under the wonted exterior appearance of nitre. Which conſideration brings into my mind what was lately told me by a very ingenious gentleman, concerning one of the eminenteſt of our *London* phyſicians, who was wont, as this confidant of his aſſured me, as an excellent ſecret, to imploy in ſome of his choice remedies that peculiar ſalt-petre, which he had drawn out of the earth digged up in church-yards.

And ſuch kind of differences would probably in other mineral bodies be taken notice of, if men's prepoſſeſſions did not make them aſcribe the variations they meet with in their experiments, rather to any other cauſe, than the unſuſpected difference of the materials imployed about them.

Nor is it only, *Pyrophilus*, among mineral bodies of the ſame name, that ſuch a diverſity is to be found; but, if narrowly looked into, it is very probable, that a greater diſparity may be diſcovered both among vegetables and animals, reputed of the ſame nature, than hath been yet taken notice of. Herbariſts indeed have exerciſed a commendable curioſity in ſubdividing plants of the ſame denomination, and few naturaliſts ignore, that there are (for inſtance) many ſorts of roſes, and of apples, which differ widely betwixt themſelves, as we ſee the difference betwixt the red roſe and the white, betwixt the crab, the pippin, and the pearmain. But beſides theſe differences, which are obvious enough to be regiſtered by botanick authors, there may be more undiſcerned ones (which yet may be conſiderable ones) betwixt the individuals of the ſame ultimate ſubdiviſion of plants, ariſing partly from the temperature of the air, which makes (for example) ſenna growing in *England* to differ much from that, which is denominated from *Alexandria*; partly from the nature of the ſoil, as is obvious in the change produced in wild ſimples tranſplanted into gardens; and partly from many other cauſes, which we have not now leiſure to inſiſt upon. But we ſee oftentimes, that one roſe much differs from another of the ſame kind, and one pearmain from another pearmain. To which we may add, that the upper cruſt or ſurface of the earth being impregnated with ſubterraneal exhalations of ſeveral ſorts, and tempered with variety of juices, it may very poſſibly be, that ſome particular plant may attract ſome ſuch juice out of a determinate ſpot of ground, as may give it exotick qualities, and make it differ even from the neighbouring plants of the ſame kind: to which purpoſe I remember, that travelling divers years ſince from *Geneva* towards *Italy*, I was in my paſſage through *Switzerland* by a gentleman of thoſe parts (whoſe brother had been formerly my domeſtick) invited to his caſtle, and entertained among other things with a ſort of wine, which was very heady, but otherwiſe ſeemed to be ſack; and having never met with any ſuch liquor during my long ſtay in thoſe parts, I was inquiſitive to know whence it was brought: and being anſwered, that it grew amongſt thoſe mountains, I could not believe it, till they aſſured me, that growing on a little ſpot of ground, whoſe entrails abounded with ſulphur, it had from the ſoil acquired its inebriating property, and thoſe other qualities, which made it ſo differing from the wine of the reſt of the vineyards of that country. And now I mention wine, give me leave, *Pyrophilus*, to put you in mind of taking notice, what a great change is made in that liquor, when upon the receſs of the ſpirits and more volatile ſulphureous parts, or elſe the new texture they make with the others, it degenerates into vinegar; and yet how little either diminution of quantity or any other alteration doth appear upon this change to the beholder's eye. And though no body is like to loſe an experiment by miſtaking vinegar for wine, becauſe both thoſe liquors and the changes of them are ſo familiar unto us; and becauſe we are wont to taſte each of them before we imploy it; yet who knows what changes there may be in other bodies, with whoſe alterations we are unacquainted, though the eye, which is oftentimes the only ſenſe employed about judging of them, diſcern no change in them? as may daily be obſerved in the ſuperannuated ſeeds of plants, which, after their having been kept long beyond their due time, loſe all their germinating power, without loſing any of their obvious qualities. And here let me further obſerve to you, that urine is made much uſe of, not only by dyers, but ſeveral other tradeſmen, in divers operations (ſome of which we may elſewhere have occaſion to treat of) belonging to their profeſſions. Now theſe men being wont indiſcriminately to employ urine, without examining, whether it be rich in ſalt or not, and how long it hath been kept, it may not be impertinent to take notice, that chymiſts, who have occaſion to diſtil it often in great quantities, aſſure me, that they find a notable diſparity betwixt urines, that of healthy

and young men abounding much more with volatile ſalt, than that of ſickly or aged perſons; and that of ſuch as drink wine freely being much fuller of ſpirituous and active parts than that of thoſe, whoſe drink is but beer or water. But becauſe the differing ſtrength of urines, though it be very probable, is not ſo eaſily to be ſatisfactorily made out, we ſhall rather inſiſt on this other obſervation confirmed to us by experience, which is, that though tradeſmen are often wont to boil ſuch and ſuch things indifferently in any urine, as if it were all one how new or ſtale it is, they may ſometimes thereby commit conſiderable errors. For recent urine, wherein the ſaline parts are yet intangled among the reſt, will ſuffer it ſelf to be boiled above one half or two thirds away, without the avolation of its volatile ſalt and ſpirits. Whereas urine, that has been divers weeks kept, is liable to a putrefaction, whereby the cement (if I may ſo ſpeak) of the ingredients that it conſiſts of, periſhing, or ſome change of texture occaſioning their disjunction, (if not alſo concurring to produce them) the component parts fall aſunder, and the ſaline particles extricating themſelves from the reſt, will even upon a very gentle heat (as trial made on purpoſe has informed us) fly away, and leave a phlegmatick and unactive liquor behind them. In confirmation whereof I muſt acquaint you, *Pyrophilus*, with what lately befel me in reference to the diſtillation of urine: for having cauſed ſome of it to be buried in earthen veſſels in a dunghill, to be there putrified, for five or ſix weeks, I was by divers occaſional journeys kept from employing it, till it had lain there between four and five months; and obſerving, when I cauſed it to be taken out, that the covers of the veſſels had not been, by him I employed to put them in, well luted on, and beſides were in ſome places crackt, I ſuſpected, that the heat of the dunghill had not only looſened the ſaline parts of the liquor, but driven them away: and accordingly by diſtilling it in a very gentle heat, and in a very high cucurbit, we obtained, inſtead of an active and ſaline ſpirit, a languid and nauſeous phlegm. And how great odds there may be betwixt ſome experiments made with recent and putrified urine, may be eaſily conceived by him, who knows what operations ſalts have in the buſineſs of colours, and is acquainted with their efficacy in thoſe other mechanical experiments, wherein urine is wont to be employed. But I fear I have dwelt too long upon this theme, and therefore I ſhall proceed to the next.

AND in the third place, *Pyrophilus*, I ſhall obſerve to you, that there is a great difference to be found among many things prepared by art, that paſs under the ſame general name: which difference may proceed partly from that, which we have already obſerved to be found in the materials of which ſuch factitious bodies are made, and partly from the way uſed in preparing them. To theſe heads many particulars may be reduced. But we ſhall at preſent reſtrain our ſelves to the mention of two ſorts of prepared bodies, namely, of ſuch as are not purified and exalted enough, and of ſuch as are ſo too much.

AND to begin with the firſt of theſe; it is very certain, that divers chymical experiments delivered by ſober authors have been believed falſe, only becauſe the menſtruums or other materials employed in the unſucceſsful trials of them were not as highly rectified, or otherwiſe as exquiſitely depurated, as thoſe that were uſed by the deliverers of thoſe experiments; ſo that oftentimes the fault of a bad menſtruum is injuriouſly imputed to a good artiſt. That experienced chymiſt *Van Helmont*, in his paradoxical treatiſe of the ſtone, endeavours (as we have elſewhere mentioned) to explicate the manner of its being generated, by the coagulation immediately enſuing upon the mixture of the two volatile ſpirits of urine and of wine. This noble experiment has been by many unſucceſsfully tried, and has been therefore by them diſcredited as a chymical fiction: and indeed the firſt, and I think the ſecond time we attempted to make that coagulum, we found nothing at all of any ſuch thing as we expected upon the confuſion of the two fore-mentioned liquors; which though never ſo much ſhaken, and afterwards permitted to reſt, did never in the leaſt meaſure coagulate, which made us long ſuſpect the experiment; till at length our favourable thoughts of that expert chymiſt making us think it poſſible, that the ſpirits we employed had not been ſufficiently exalted, we dephlegmated ſome by more frequent, and indeed tedious rectifications (which yet proved but neceſſary) and then were ſatisfied by more accurate trials, that *Helmont* had not miſinformed us.

So likewiſe the ſame author in his treatiſe *de Peſte* much extolling, as a friend to the ſtomach, the entrails, the nervous parts, and even the head, the tincture or ſolution of amber made with ſpirit of wine (which medicine is indeed no ignoble one, when adminiſtered to conſtitutions, that can well bear the heat of it) divers phyſicians and chymiſts have attempted the preparing of this tincture with ſuch bad ſucceſs, that they have given out, that either *Helmont* delivered what was not true, or concealed ſome conſiderable circumſtance of the proceſs.

WHEREAS having digeſted ſufficiently dephlegmed ſpirit of wine upon very finely powdered amber, (which, if it be the higher-coloured, yields the deeper tincture) in a very gentle heat, (for the neglect of which caution even expert artiſts have often loſt their pains and glaſſes) we have ſeveral times had a good yellow tincture of amber, which was diſcernable in the menſtruum both by the ſmell and taſte; and to ſatisfy ſome, that ſuſpected the tincture to proceed but from the exaltation of the menſtruum it ſelf by digeſtion, and to manifeſt, that it was a real ſolution of the ſubtiler parts of the amber, we poured ſome drops of it into beer, or water, into which the ſpirit of wine ſuddenly diffuſing itſelf, the diſſolved amber was plainly diſcernable ſwimming like a thin film upon the ſurface of the liquor, whence, little by little, it ſteamed away into the air.

THERE is likewiſe, as we have tried, to be drawn with ſpirit of wine from pure ſalt of tartar a pretty high tincture, and of a taſte, which I thought not unworthy the taking notice of: but

but having a while ſince tried to draw this tincture with ſpirit of wine, which (unknown to me) was much too weak for that purpoſe, after I had kept the glaſs a while in digeſtion, coming to look whether or no the ſpirit was tinged, I found, that the ſalt of tartar had drawn to it ſelf and imbibed the aqueous particles of the ſpirit of wine, and being thereby (for a great part of it) diſſolved into a liquor like that, which is commonly called oil of tartar *per deliquium*, the ſubſiding ſalt was by the interpoſition of that ſaline liquor protected from the action of the ſpirit of wine; which being by this new way dephlegmed, would not mix with the ſaline liquor, but ſwam intirely above it. To which I ſhall only add in general, that the German chymiſts are divers of them ſo accurate in the rectification of their ſpirit of wine, that in *England*, where we are wont to be leſs careful about that particular, it is uſual enough for thoſe experiments of theirs to be unſucceſsfully tried, wherein the alcohol of wine (as they call it) is requiſite.

And as ſpirit of wine, ſo many other menſtruums are made unfit for the perfecting of divers real experiments, barely by their not being ſufficiently freed from their weakning aquoſity.

Nor is it only, *Pyrophilus*, in menſtruums, but in divers other bodies, that the want of an exquiſite depuration may produce in experiments variety of events. As for inſtance, it has been complained of by ſober men, that their preparations of ſilver, though never ſo carefully made, have been apt to produce violent vomits; whereas we have not obſerved a well-prepared medicine of duly refined ſilver to work emetically, even in women and girls, but by ſeige or urine. But we cannot wonder at the violent operation of medicines made of ordinary ſilver: for not only that, which is coined, is wont, as the mint-maſters themſelves have confeſſed to me, to be allayed with ſometimes about a twelfth part, ſometimes a ſmaller or greater proportion of copper, for the greater conveniency of the coin; but even that ſilver, which is commonly at great rates ſold for refined ſilver, is not wont to be ſufficiently freed from its copper. Which I not long ſince manifeſted in the preſence of one of our richeſt and eminenteſt refiners, by diſſolving ſome of his pureſt ſilver in his own aqua fortis; for the greenneſs of the ſolution quickly betrayed the adherency of *Venus* to the ſilver. And no wonder; for I have ſeldom ſeen our chiefeſt refiners blow off from their ſilver upon the teſt above half its weight of lead, whereas we think not our ſilver ſufficiently refined for ſome purpoſes, till it have been freed from five or ſix times its weight of *Saturn*; and then it has ſometimes afforded a ſolution almoſt as clear as water, with only now and then a light touch of ſky-colour, but nothing near ſo high as the ceruleous (liquor that is ſuppoſed to be a true) tincture of ſilver, artificially ſeparated from the reſt of the body.

Now that ill effects by the mixture of copper may be produced in ſuch medicines, as ought to be of pure ſilver, he, that is acquainted with the violent emetick qualities of *Venus*, can ſcarcely doubt. And as in men's bodies, ſo in other ſubjects, thoſe experiments may eaſily deceive the artiſt's expectation, when he hopes to perform with ſilver and copper together thoſe things, which ſuppoſe and require ſilver without copper, or any adventitious metal: and as ſilver, ſo gold is very often employed for pure, when it is not ſo: for even the foliated gold, which is commonly ſold here in *England*, how fine ſoever it is reputed, is not altogether free from the pollutions of other metals; for our gold-beaters, though for their own profit ſake they are wont to uſe the fineſt coined gold they can get, (as that which is capable of the greateſt extenſion under the hammer) yet they ſcruple not to employ coined gold, and that the mint-maſters (as themſelves inform me) are wont to allay with copper or ſilver, to make the coin more ſtiff, and leſs ſubject to be waſhed by attrition. And as for thoſe many goldſmiths and chymiſts, who think their gold moſt requiſitely refined, when they have blown from it on the teſt a due proportion of lead, they may be therein ſometimes miſtaken: for though *Saturn* may carry away withhim all the copper, that did imbaſe the gold, yet he does not likewiſe free it from the ſilver, (for which purpoſe aqua fortis is therefore wont to be uſed) nay, the ſkilfulleſt refiner, that I ever yet knew, hath ſeveral times affirmed to me, that coupling fine gold with lead, the gold has after retained and protected from the fire a proportion of ſilver, that lay lurking in the lead, and was afterwards ſeparated from the gold by aqua fortis, but in ſo ſmall a quantity, that the experiment (the coſt and pains conſidered) was not lucriferous. And of this ſort of inſtances, *Pyrophilus*, more might be preſented, if we did not think prolixity might be unwelcome to you.

But as many experiments ſucceed not according to expectation, becauſe the menſtruums employed about them were not pure enough; ſo ſome miſcarry, becauſe ſuch menſtruums are but too exactly depurated: for it is not ſo much the purity of liquors in their kind, as their fitneſs for the particular purpoſe, to which they are deſigned, that is in experiments to be principally regarded. For inſtance, we have ſometimes, for recreation ſake, and to affright and amaze ladies, made pieces of white paper and linnen appear all on a flame, without either burning, ſindging, or as much as diſcolouring them. This is performed by plunging the paper very thoroughly in weak ſpirit of wine, and then approaching it to the flame of a candle; by which the ſpirituous parts of the liquor will be fired, and burn a pretty while without harming the paper. But if this experiment be tried with exquiſitely rectified ſpirit of wine, it will not ſucceed. Of this phænomenon this plauſible reaſon has been aſſigned, that the flame of the ſpirit of wine is ſo pure and ſubtile, that, like an *ignis lambens*, it will not faſten upon the paper. But experience has informed us, that this conjecture is but a miſtake, for the flame of ſpirit of wine is ſo hot, that I have in lamp-furnaces employed

ſpirit

ſpirit of wine inſtead of oil, and with the ſame flame I have not only lighted paper, but candles, and even melted foliated gold. The true reaſon therefore, why that paper is not burned by the flame, that plays about it, ſeems to be, that the aqueous part of the ſpirit of wine being imbibed by the paper, keeps it ſo moiſt, that the flame of the ſulphureous parts of the ſame ſpirit cannot faſten on it. And therefore when the deflagration is over, you ſhall always find the paper moiſt; and ſometimes we have found it ſo moiſt, that the flame of a candle would not readily light it. And on the other ſide, having purpoſely made trials of plunging paper into ſufficiently dephlegmated ſpirit of wine, the paper not having aqueous moiſture to defend it, was very readily kindled and burned by the flaming ſpirit. And one of our beſt ways to try the pureneſs of ſpirit of wine is grounded on this very ſuppoſition: for dipping it in a cotton-wiek like that of a candle, and ſetting it on fire, if the flame faſten on the wiek, it is a ſign of the goodneſs of the ſpirit; but if it do not, we conclude it to be weak, and not ſufficiently dephlegmed. It hath been likewiſe obſerved, that aqua fortis will work more readily on lead, if it be allayed with water, than if it be purely rectified. I otherwhere alſo mention an aqua fortis I have uſed, which was ſo ſtrong, that it would not well diſſolve ſilver it ſelf, unleſs I firſt diluted it with fair water. And within this very week, wherein I write theſe things, I have had an unwelcome proof, that liquors may by too exquiſite a depuration be made unfit for our purpoſes. For having, to gratify ſome ingenious friends, made a certain menſtruum, wherewith we had formerly done ſome things upon gold, which were (not altogether without cauſe) thought ſtrange enough, we took care at this time to ſeparate it from whatever was either of an aqueous or an earthy nature, more exactly than ever we had formerly done. But coming to make uſe of this ſort of menſtruum, we found to our trouble and loſs, that inſtead of performing its wonted operations upon gold better than before, we could do nothing at all with it: for it will not now by heat it ſelf be brought to touch gold, though that metal were wont to be diſſoluble in it even *in frigido*. And to ſatisfy you, that it was the too exquiſite depuration of this liquor, eſpecially from its terreſtrial parts, that thus unfitted it to touch a metal, which is otherwiſe wont to melt as it were naturally in it without ebullition (almoſt like ice in luke-warm water;) we will ſubjoin, that not only we in vain tried to make it ſerviceable by weakening it with fair water; but having, for trial-ſake, taken a little of this numerical parcel of liquor before it was ſo carefully rectified, we found, that it diſſolved crude gold as well as we had reaſon to expect. And it would be conſidered, whether or no in the extraction of the tinctures of ſeveral bodies, chymiſts do not only put themſelves to a needleſs, but to a prejudicial trouble, when they refuſe to employ any other ſpirit of wine, than that which is highly rectified. For, though in many bodies the parts deſired by the artiſts being the ſulphureous ones, the menſtruum is the better for an exquiſite dephlegmation; yet in divers other concretes the uſeful and efficacious parts have in them ſomething of ſaline, which makes them more free to impregnate copiouſly ſuch liquors, as have ſome aqueous mixed with their ſulphureous parts.

BUT becauſe there is nothing more eaſy than by diluting ſpirit of wine, though never ſo ſtrong, to make it as weak as one pleaſes; and becauſe pure ſpirit of wine is that of all other menſtruums, that chymiſts generally make moſt uſe of, and which coſts them moſt of charge and trouble, (inſomuch that here in *London* that, which is perfectly dephlegmed, is valued, in their ſhops that ſell both, at ten times the price of common ſpirit of wine;) I preſume you will not take it ill, that without being obliged to it by the title of this diſcourſe, I take this occaſion to acquaint you with the way I employ to obtain dephlegmed ſpirit of wine; eſpecially ſince the practice of the common way of frequent rectifications is (not to mention other inconveniences) wont to prove either exceeding tedious, or inſufficient. Put then about an inch thick of tartar calcined to whiteneſs, (for I find it not neceſſary to reduce it to a ſalt) and very dry, into the bottom of a tall and ſlender glaſs body, and pour on it as much ſpirit of wine, that has been but once rectified, as will, when they have been ſhaked together, ſwim above the tartar a finger's breadth (more or leſs in proportion to the tartar you put in) and then the head and receiver being carefully faſtened on again, in a gentle heat draw off the ſpirit of wine, ſhifting if you pleaſe the receiver, when about half is come over, and if need be, rectifying once more all that you diſtil upon dry calx of tartar as before. Whether or no you may meet with this method in ſome chymical books, I know not: but it ſeems, that either it has not been clearly taught, or has been propoſed by ſuſpected authors, or elſe among other proceſſes, by being found in whoſe company it has been diſcredited. For the moſt ancient and experienced diſtillers I have met with, have either contented themſelves to follow the common way of repeated rectifications, though thereby they loſe much time, and much ſpirit of wine; or elſe have had recourſe to peculiar veſſels of ſuch a height, as beſides that they are neither eaſily nor cheaply to be procured, do not, as far as I have hitherto ſeen, excuſe the need of reiterated rectifications. Whereas, when we conſidered, that the fixed ſalt of tartar readily imbibes aqueous bodies, and that yet it will not at all mix with pure ſpirit of wine, it was eaſy to conclude, that the phlegmatick part of the ſpirit of wine would be ſoaked up by the alcalizate ſalt, whereby the inflammable part would be freed from it. And accordingly when we proceeded after the manner above preſcribed, we found, that the liquor, that was produced upon the firſt rectification from the ſalt, being fired in a warm ſilver-ſpoon, did not leave behind it one drop of phlegm, or ſo much as the leaſt moiſture upon the ſpoon; nay, and indeed did endure a ſeverer examen, to which for curioſity's ſake we thought fit to

put it. And when the diſtillation was carefully made, we found by frequently (for trial-ſake) ſhifting the receiver, that all the ſpirit that aſcended was (to ſenſe) equally pure, ſince that which came up laſt of all, even till the calx ſeemed to begin to grow dry, by beginning to cleave at the top, did burn all away, as well as that which came over firſt. And having for further trial taken out the calcined tartar, and diſtilled it with a good fire, it yielded us pretty ſtore of a nauſeous and ſtrongly ſcented liquor, which ſeemed to be but phlegm, both to the taſte, and by its not being at all inflammable, though carefully tried. The ſame calx of tartar being kept in ſome earthen veſſel upon the fire till it be well dried, which will require a good heat, may be employed more than once in this operation. And it was not needleſly that we preſcribed bodies tall and ſlender; for we found not the experiment to ſucceed in large and low ones, and much leſs in retorts, in which the phlegm is wont to riſe together with the ſpirit; yet we found, that provided the diſtillation were made with a ſufficiently mild heat, a glaſs, though very broad, and but moderately high, would ſerve the turn ſo far, as that the firſt half that aſcended (the other being very weak) proved a ſpirit, that in a ſilver-ſpoon would burn perfectly all away. And becauſe white calx of tartar is ſometimes not ſo eaſy to be procured, we will add, that we have for trial-ſake ſometimes ſubſtituted quick-lime, or ſalt of pot-aſhes, (made by a ſingle ſolution, filtration, and coagulation) with no bad ſucceſs, eſpecially in caſe of removing the receiver before the aſcenſion of the laſt part of the liquor, though even that it ſelf has ſometimes from quick-lime come up inflammable enough. And therefore this alcohol of wine we peculiarly call the alcalizate ſpirit of wine; and the rather, becauſe *ſpiritus vini tartarizatus*, which perhaps may be thought the propereſt name for it, is employed by eminent chymical writers to ſignify a different thing. And a practicable way of making ſuch an alcalized and pure ſpirit of wine we thought not unfit to teach you here once for all, in regard the menſtruum is ſo highly uſeful, not only for tinctures, extracts, and many other chymical operations, but in the making of divers philoſophical experiments, and particularly ſome of thoſe, which you may meet with in our writings. And an eminently ingenious perſon (but to me a ſtranger) chancing to get a ſight of this eſſay, was pleaſed to give me thanks for this laſt part of it; becauſe, though he had very often made uſe of ſalt of tartar to improve ſpirit of wine, yet he did it before, not to dephlegm the weaker liquor, but to acuate the ſtrong with the alcali: which though I deny not to be a thing feaſible, yet (as I told him) unleſs it be ſkilfully attempted, the highly rectified liquor, that is poured on, will rather leave ſome of its moſt ſpiritous parts behind, than carry up ſo fixt a ſalt.

The Second ESSAY,

Of Unſucceeding EXPERIMENTS.

WHAT has been already ſaid, *Pyrophilus*, may, I hope, ſuffice to ſhew you, how experiments may miſcarry upon the account of the materials employed in trying them. And therefore we ſhall now paſs on to conſider the contingencies, to which experiments are obnoxious, upon the account of circumſtances, which are either conſtantly unobvious, or at leaſt are ſcarce diſcernible till the trial be paſt. And becauſe theſe circumſtances can hardly be diſcourſed of in an accurate method, (which their nature will ſcarce admit of) I ſhall not tie myſelf to any other order in ſetting down the inſtances, which occur to me on this occaſion, than that wherein they offer themſelves to my memory.

AND firſt I muſt acquaint you with what was not long ſince ſeriouſly related to me by doctor *K.* a perſon exceeding far both from the cuſtom, and, in this particular, from the temptation of telling untruths. He then aſſured me, that lending his laboratory in *Holland* to a friend of his during his own abſence, and leaving in that laboratory among other things great ſtore of aqua fortis of ſeveral compoſitions, which he had made, to employ about his famous ſcarlet-dye, this friend of his ſent him word a while after his departure, that by digeſting gold with an aqua fortis, he had ſeparated the tincture or yellow ſulphur from it, and made it volatile, (the remaining body growing white) and that with this golden tincture he had, not without gain, turned ſilver (as to part of it) into very perfect gold. Upon which advertiſement the doctor ſpeedily returning to his laboratory, did himſelf with the ſame aqua fortis divers times draw a volatile tincture of gold, which did turn ſilver into true gold: and (that I may add that upon the bye, to gratify your curioſity) when I demanded, whether or no the tincture was capable to tranſmute or graduate as much ſilver, as equalled in weight that gold, from whence the tincture was drawn, he aſſured me, that out of an ounce of gold he drew as much ſulphur or tincture, as ſufficed to turn an ounce and a half of ſilver into that nobleſt metal. Which I am the more diſpoſed to believe, partly

partly becauſe my trials permit me not to doubt of the ſeparableneſs of a yellow ſubſtance or tincture from gold; and partly becauſe I am tempted to think, that ſilver may have in it a ſulphur (to ſpeak in the chymiſts language) which maturation is capable to graduate into a golden one, by having been certified by the obſervations of men very experienced in metalline affairs, (and perhaps too by my own) that ſometimes by corroſive liquors (which Sir *Francis Bacon* alſo, if I miſtake not, ſomewhere obſerves) and ſometimes by the operation of common ſulphur (eſpecially well opened, and aſſociated with fit ſalts) ſilver has afforded ſome grains of very pure gold. But our doctor found himſelf much miſtaken in the hopes of growing rich by this experiment; for a while after endeavouring to make it again, his hopes were fruſtrated, which he aſcribes to the aqua fortis, and therefore has attempted the ſame work afreſh. But ſince all his trials have been hitherto fruitleſs, it is not improbable, that the diſappointment proceeded from ſome other more abſtruſe cauſe; for we find ſuch adventures to have ſometimes befallen artiſts irreparably. And *Glauber* alone, if you will therein credit him, tells us of ſeveral ways, by which he made gold once, and could not do it again. Upon which ſubject I muſt not omit thoſe very illuſtrious teſtimonies and inſtances of this nature, that I find recorded by that ornament of his age and quality, the prince of *Mirandola*, in his treatiſe

Lib. 3 cap. 6. de Auro. *Novi* (ſays he) *qui mihi aſſeruerit ſemel ſe ex mobili argento, quod vivum dicitur, ſtabile verumque argentum confeciſſe ſuccis & foliis herbarum, idque vendidiſſe peritis explorandæ metallicæ veritatis; eiſdem mox uſum ſe foliis fruſtra, & quod ſemel perfecerat, nunquam alias, quanquam id ſæpe tentaverit, perficere potuiſſe.*

Alium novi (ſays he further) *qui adhuc apud vivos moratur, cui cum aurum & argentum circiter quindecies per artem effectum eſſet, amiſit artem eam, acceptique oraculo ſocii per quietem habito, id ingratæ mentis vitio contigiſſe. Ut hinc etiam veritatem apoſtolici dicti condiſcamus, Neque qui plantat, neque qui rigat, eſt aliquid, ſed incrementum dat Deus.* And to both theſe narratives our learned prince does in the ſame book add divers others. *Retulit quidam mihi* (ſubjoins he) *ſeſe aurum ex argento faciſſe ſemel magnâ copiâ; ſecundo ſe uſum eiſdem rebus, feciſſe quidem, ſed minimâ ſemper quantitate, ſic ut detrimentum lucro majus eſſe ſupputaverit. Veniſſe in mentem, uti detrimentum effugere poſſit, ſi non ex argento, ſed ex ære melioris conditione metalli, ſeſe conſequi experiretur, idque ſe conjecturis firmis nixum tentaviſſe: cumque in eo fuiſſet, ut rem ſeſe adepturum ſperaret, miris modis eveniſſe, ut nihil omnino conſequeretur.*

Idem (continues the prince) *affirmavit ab amico, qui expertus hoc ipſum fuerat accepiſſe, qui cum ex cinnabari argentum feciſſet optimum, ſæpenumero ſeſe poſtea inſiſtentem operi majore cum diligentia ſemper eventu rei fuiſſe fruſtratum.* And to theſe relations of this famous prince I could add others of ſome acquaintances of mine, who having either once or twice made *luna fixa* (as artiſts call that ſilver, which wanting but the tincture of gold abides the trial of aqua fortis, *&c.*) or ſome other lucriferous experiment, have ſince in vain attempted to do the like again; and yet have their eyes ſo dazzled by the gold and ſilver they have (either ſeparated or) made, that they are not to be prevailed with to deſiſt from proſecuting their uncertain hopes.

THAT divers experiments ſucceed, when tried in ſmall quantities of matter, which holds not in the great, it may ſave you ſomething to be advertiſed of; divers projectors, eſpecially chymiſts, having already very dearly bought the knowledge of that truth, for oftentimes a greater and unwieldy quantity of matter cannot be expoſed in all its parts to a juſt degree of fire, or otherwiſe ſo well managed, as a leſs quantity of matter may be ordered. But this is ſo manifeſt a truth to thoſe, that have dealt much in experiments, that whereas many chymiſts would be vaſtly rich, if they could ſtill do in great quantities what they have ſometimes done in little ones, many have undone themſelves by obſtinately attempting to make even real experiments more gainful.

I HAVE not been very ſollicitous to ſubjoin particulars to the foregoing obſervations, becauſe that by reaſon of the contingency of ſuch experiments, as would be the moſt for my preſent purpoſe, you might poſſibly be tempted to loſe toil and charges upon trials, very likely not only to delude your hopes, but perhaps to make you diſtruſt the fidelity of our relations. Yet for illuſtration-ſake of what we have delivered, I am willing to mention ſome few contingent experiments, that occur to my thoughts.

AND firſt, it is delivered by the Lord *Verulam* himſelf, as I remember, and other naturaliſts, that if a roſe-buſh be carefully cut as ſoon as it has done bearing, it will again bear roſes in the autumn. Of this many have made unſucceſsful trials, and thereupon report the affirmation to be falſe; and yet I am very apt to think, that the Lord *Verulam* was emboldened by experience to write as he did. To clear up which difficulty, let me tell you, that having been particularly ſollicitous about the experiment, I find by the relation both of my own and other experienced gardeners, that this way of procuring autumnal roſes will in moſt roſe-buſhes moſt commonly fail, but in ſome, that are good bearers, it will ſucceed; and accordingly having this ſummer made trial of it, I find, that of many buſhes, that were cut in *June* in the ſame row, the greater number by far promiſe no autumnal roſes, but one, that hath manifeſted it ſelf to be of a vigorous and prolifick nature, is at this preſent indifferently well ſtored with damaſk-roſes. And there may be alſo a miſtake in the kind of roſes; for experienced gardeners inform me, that the muſk-roſe will, if it be a luſty plant, bear flowers in autumn without the help of cutting. And therefore that may be miſ-aſcribed to art, which is the bare production of nature. And cinnamon roſe-buſhes do ſo much better thrive by cutting than ſeveral other ſorts, that I remember, this laſt ſpring, my gardener having (as he told me) about mid *April* (which

was as ſoon as that kind of roſe-buſh had done bearing) cut many of them in my garden, I ſaw about the middle of *June* ſtore of the ſame buſhes plentifully adorned both with buds and with blown flowers.

AN uncertainty not unlike that, which we have newly taken notice of in the experiment of producing autumnal roſes, has been likewiſe obſerved in the attempts, that have been made to make divers ſorts of fruit grow upon the ſame tree. And as for differing ſorts of fruits of the ſame denomination, as apples, pears, *&c.* though ſome ſevere naturaliſts are unwilling to believe, that they can be made to grow upon the ſame tree; yet we dare not imitate their ſeverity, having lately ſeen various ſorts of pears fed by the ſame tree, and elſewhere three and twenty ſorts of apple-grafts flouriſhing upon the ſame old plant, and moſt of them adorned with fruit. Nay, and though the fruits be not of the ſame denomination, yet if they be of kin in nature, they may very poſſibly be brought to grow on the ſame tree: for we lately gathered ripe apricocks and ripe plums upon one tree, from which we likewiſe expect ſome other ſorts of ſtone-fruit. But to make fruits of very differing natures be nouriſhed proſperouſly by the ſame ſtock, is ſo difficult a thing, that we can at moſt but reckon it among contingent experiments. For though *Pliny* and *Baptiſta Porta* relate their having ſeen each of them an example of the poſſibility of producing on one tree great variety of differing fruits; and though ſuch a perſon as the deſervedly-famous aſtronomer Dr. *Ward* aſſures me, that he has particularly taken notice of pears growing upon an apple-tree; and I elſewhere add a reſembling obſervation of ours; yet certainly this experiment has been for the moſt part but very improſperouſly attempted; nor have I yet ever ſeen it ſucceed above once, though tried with very much care and induſtry. And I remember, that this very year, in the ſame garden where I gathered the apricocks and plums above mentioned, I ſaw the cions of a pear-tree ſo ſkilfully grafted upon an apple-ſtock, that it flouriſhed very much with bloſſoms in the ſpring, and gave me great hopes, that it would bear fruit this newly-paſt ſummer, but has deceived my expectation; as divers other plants ſo grafted in the ſame garden have for many years deluded the hopes of the ſkilful maſter of it, who aſſures me, that though divers of them did for ſome years ſucceſſively afford promiſing bloſſoms, yet they all decayed away without bearing any of them any fruit. Which yet may ſeem ſomewhat ſtrange, ſince not only we have this ſummer gathered pears upon a graft, which a divine, to whom the garden belongs, affirmed to have been grafted upon a quince-tree; and the induſtrious *Kircher* tells us, that *Experientia docet Perſicum moro inſitum fructus proferre, &c. de quo nullum eſt dubium utpote vulgare penè:* 'but 'experience tells us, that as little as a white-'thorn and a pear-tree ſeem of kin, a cion of 'the latter will ſometimes proſper well, being 'grafted upon a ſtock of the former.'

Artis Mag. Lucis & Umbræ, lib. 1. p. 3. cap. 6.

To contingent experiments, *Pyrophilus*, you may, if you pleaſe, refer what is delivered by thoſe learned writers, who affirm, that if a lixivium made of the aſhes or fixed ſalt of a burned plant be frozen, there will appear in the ice the idea of the ſame plant; for we have divers times purpoſely made trial of this experiment without the promiſed ſucceſs. And I remember, that in the laſt cold ſeaſon, proper for ſuch trials, I purpoſely made a lixivium of fair water and ſalt of wormwood; and having frozen it with ſnow and ſalt after the manner of congelation elſewhere declared, I could not diſcern in the ice any thing more like to wormwood than to ſeveral other plants. And having about the ſame time, and after the ſame manner, expoſed to congelation a thin phial full of a ſtrong decoction of wormwood, (from which an idea of the plant may be more probably expected) thoſe, to whom I ſhewed it, after it was frozen, could diſcern as little like wormwood in it as my ſelf. It is true, that in both theſe phials the ice ſeemed ſomewhat oddly figured; but it is true alſo, not only that we have obſerved that water, wherein a ſaline body, as ſalt-petre, or ſea-ſalt, or ſugar, *&c.* has been diſſolved, has afforded us ice, which ſeemed to ſhoot into ſeveral figures, but even in ordinary water congealed we have often ſeen ice figured, as if the water had been no elementary body; which needs not be admired, ſince (to omit other cauſes, which may concur to the production of this effect) many waters gliding through earths abounding in ſaline particles of this or that nature, may be eaſily, in their paſſage, impregnated with them; whence perhaps it comes to paſs, that dyers find ſome waters very fit, and others very unfit for the dying of ſcarlet and ſome other colours. And therefore we cannot but think, that the figures, that are oftentimes to be met with in the frozen lixivium or decoction of a plant, will afford but uncertain proofs, that the idea of each, or ſo much as of any determinate plant, diſplays it ſelf conſtantly in that frozen liquor. And I much fear, that moſt of thoſe, that tell us, that they have ſeen ſuch plants in ice, have in that diſcovery made as well uſe of their imagination as of their eyes. And it is ſtrange to obſerve what things ſome men will fancy, rather than be thought to diſcern leſs than other men pretend to ſee. As I remember Mr. *R.* the juſtly famous maker of dioptrical glaſſes, for merriment telling one, that came to look upon a great tube of his of thirty foot long, that he ſaw through it in a mill ſix miles off a great ſpider in the midſt of her web; the credulous man, though at firſt he ſaid he diſcerned no ſuch thing, at length confeſſed he ſaw it very plainly, and wondered he had diſcovered her no ſooner. But yet, *Pyrophilus*, becauſe two or three ſober writers do ſeriouſly relate ſome ſtories of that nature upon their own obſervation, I am content for their ſakes to reckon their experiments rather among the contingent than the abſolutely falſe ones: for it is not impoſſible, but that among the many figures, which frozen liquors do ſometimes put on, there may appear ſomething ſo like this or that plant, that being looked upon

upon with the favourable eye of a prepoſſeſſed beholder, it may ſeem to exhibit the picture of the calcined vegetable: and we ourſelves, not very long ſince, ſetting to freeze in ſnow and ſalt a fine green ſolution of good verdegreaſe (which contains much of the ſaline parts of the grapes coagulated upon the copper by them corroded) obtained an ice of the ſame colour, wherein appeared divers little figures, which were indeed ſo like to vines, that we were ſomewhat ſurprized at the experiment; and that which increaſed our wonder was, that another part of the ſame ſolution being frozen in another phial by the bare cold of the air, afforded us an ice angularly figured, (as we have obſerved the ice of ſaline liquors oftentimes to be) but not at all like that made by the application of ſnow and ſalt. And having, for further trial ſake, ſuffered that ice, wherein the vines appeared to thaw of itſelf, and having then frozen the liquor a ſecond time in the ſame phial, and after the ſame manner as formerly, we could not diſcern, in the ſecond ice, any thing like that, which we had admired in the firſt. And in wine and vinegar, as much as thoſe liquors partake of the nature of the vine, we have not, after congelation, obſerved any peculiar reſemblance of it in figure.

THE mention we have been making of ice brings into my memory another experiment, which may perhaps be reckoned likewiſe among contingent ones, and that is the experiment of burning with ice as with a glaſs lens; which though ſome eminent modern writers preſcribe to be done, without taking notice of any difficulty in it, yet both we and others, that have induſtriouſly enough tried it, have met with ſuch defeating circumſtances in it, eſpecially from the uniform texture wont to be met with in moſt ice, that the making of ſuch burning-glaſſes may be well enough referred to thoſe experiments, whoſe conſtant ſucceſs is not to be relied on, as we elſewhere more particularly declare.

IN the trade of dying there is ſcarce any tinging ingredient, that is of ſo great and general uſe amongſt us as woad or glaſtum; for though of itſelf it dye but a blue, yet it is uſed to prepare the cloath for green and many other of the ſadder colours, when the dyers have a mind to make them permanent, and laſt without fading: but yet in the decocting of woad to make it yield or ſtrike its colour, there are ſome critical times and other circumſtances to be obſerved; the eaſy miſtake of which oftentimes defeats the dyer's expectation to his very great loſs, which ſometimes he knows not to what to impute, of which I have heard ſeveral of them complain: and therefore divers of our leſs-expert dyers, to avoid thoſe hazards, leave off the uſe of woad, though growing plentifully enough here in *England*, and inſtead of it employ indico, though it coſt them dearer, as being brought hither ſometimes from *Spain*, ſometimes from the *Barbadoes*, and oftentimes even from the *Eaſt-Indies*.

OUR *London* refiners, when, to part ſilver and copper, they diſſolve thoſe mixed metals in aqua fortis, are wont afterwards to dilute the glutted menſtruum with ſtore of fair water, and then with copper-plates to ſtrike down the diſſolved ſilver. But becauſe by this manner of proceeding much copper is wont, after the ſeparation of the ſilver, to remain in the menſtruum, as may appear by its high tincture, that this thus impregnated liquor may be improved to the beſt advantage, they are wont to pour it upon what they call whiting, (which is ſaid to be a white chalk or clay finely powdered, cleanſed, and made up into balls) wherewith the tincted parts incorporating themſelves, will, in ſome hours, conſtitute one ſort of verditer fit for the uſe of painters, and ſuch other artificers as deal in colours, leaving the remaining part of the menſtruum an indifferently-clear liquor; whence they afterward, by boiling, reduce a kind of ſalt-peter fit, with the addition of vitriol, (and ſome freſh nitre) to yield them a new aqua fortis.

AND theſe things I mention, *Pyrophilus*, that you may know what I mean, when I tell you, that ſometimes the refiners cannot make this verditer for a great while together, and yet cannot tell, whence their diſability to make it proceeds. Of which contingency I remember I lately heard one of the eminenteſt and richeſt of them ſadly complain, affirming, that neither he, nor divers others of his profeſſion, were able, not long ſince, to make verditer for divers months together; and that ſeveral others were yet at a loſs in reference to that particular: though for his part he had, without knowing the cauſe of this contingency, found a remedy for it, namely, to warm the menſtruum well before it be poured on the whiting; on which, when the liquor was warm, the tincted parts would faſten, though they would not, whilſt (according to the cuſtom of refiners) it was poured on cold.

MAKING likewiſe the other day a viſit to the chief copperas work we have in *England*, one of the overſeers of it, who went along with me to ſhew me the contrivance of it, aſſured me, that divers times, by the miſtake or neglect of a circumſtance in point of time, they had loſt, and are yet ſubject to loſe, ſome thouſands of pounds of vitriol at a time, which in ſpite of their wonted, but not ſufficiently attentive and ſkilful care, would degenerate into an unctuous ſubſtance, not to be reduced into good vitriol again; unleſs by the tedious way of throwing it abroad, and expoſing it with the unprepared ſtones, from which they draw their vitriol, to the rain and ſun to be opened anew, and fitted for the yielding of vitriol after the ſame manner with thoſe crude minerals.

UPON this occaſion I muſt not omit, becauſe much conducing to the ſcope of our preſent diſcourſe, a memorable relation, that I have met with in the Indian Hiſtory of the learned *Joſephus Acoſta*, who diligently ſurveyed the famous and almoſt ineſtimable mines of *Peru*, and (for one that was not a chymiſt) has delivered divers conſiderable and judicious obſervations about them. That which I am now to mention, is in that chapter, where he treats of the ſilver of the *Indies*, ſet down in theſe

Joſephus Acoſta, lib. 4. cap. 5.

words: 'It is ſtrange to ſee not only the difference betwixt the refining of metal by fire, and without it by quick-ſilver, but alſo that ſome of theſe metals, which are refined by the fire, cannot well be molten with any artificial wind, as with bellows, but when it is kindled, and blown with the natural air or natural wind. The metal of the mines of *Porco* is eaſily refined with bellows; and that of the mines of *Potoſi* cannot be molten with bellows, but only by the breath of their guayars, which are ſmall furnaces upon the ſides of the mountains, built expreſsly where the wind lies, within the which they melt this metal: and though it be hard to yield a reaſon of this difference, yet it is moſt certain and approved by long experience.'

IF there be any trade, that obliges the artificers to be aſſiduouſly converſant with the materials they employ, it is that of the glaſs-men; and yet even to them, and in their moſt ordinary operations, there happen now and then little accidents, which, though they know not well to what to aſcribe, are not yet capable of hindering them from doing ſometimes what they have done a thouſand times. And I remember, that among the laſt times I have been at a glaſs-houſe, an eminently-ſkilful workman, whom I had purpoſely engaged to make ſome veſſels for me, that required more than ordinary dexterity, was not able, when I came thither, to make metal (as they call that colliquated mixture of ſand and fixt ſalt, whereof they blow their glaſſes) tolerably fit to be employed: wherefore he deſired me to take the pains to come again another day, and he would try to repair his unluckineſs. But the next time I came, though it were upon appointment, his metal proved again unſerviceable, and inſtead of being colourleſs, when it was cold, looked as if it had been ſtained with blue and yellow, and was beſides brittler than it ought to have been. So that it need be no ſuch wonder, if philoſophers and chymiſts do ſometimes miſs of the expected event of an experiment but once, or at leaſt but ſeldom tried, ſince we ſee tradeſmen themſelves cannot do *always*, what, if they were not able to do *ordinarily*, they could not earn their bread.

IT is affirmed by *Helmont* and others, that treat of the *Lapides Cancrorum*, that they grow within the ſkulls of thoſe craw-fiſhes, from whence they have their name: but I have known good anatomiſts complain, that they have ſought them in vain in the heads of thoſe fiſhes, which may well make them diſtruſt the veracity of thoſe, that aſcribe them to that ſort of animals; yet we have often taken thoſe ſtony concretions out of the heads of craw-fiſhes. But paſſing lately through *Hungerford*, a town famous for the plenty of ſuch kind of fiſh, we made diligent enquiry concerning their nature, and were there informed by thoſe, that looked to them, that the concretions above-mentioned are to be found in their heads but about that ſeaſon of the year, wherein they ſhift their ſhells, and that at other times of the year, ſeveral perſons had in vain endeavoured to ſtore themſelves with crabs-eyes at *Hungerford*. And indeed, having at the laſt time of my being there (which was about the latter end of *June*) cauſed divers large ones to be taken out of the water, we found theſe little ſtones in the head but of one of them; whereas about a fortnight before, which was near the ſummer ſolſtice, paſſing by that place, we found in the wonted parts of the heads ſeveral ſuch concretions, as to bigneſs and ſhape, but ſo ſoft, that we could eaſily cruſh and diſcind them betwixt our fingers. And certainly the miſtake of the circumſtance of time has much prejudiced the reputation of many truths: and I remember, that *Aſellius*, to whoſe anatomical fortune the world is ſo much beholden, ingenuouſly acknowledges, that he had like to have loſt the diſcovery of the milky veins, becauſe having at firſt ſuſpected thoſe unlooked-for white veſſels, which he took notice of in the meſentery of a dog diſſected alive, to be ſome irregular ramifications of nerves, he was much confirmed in his conjecture by the next dog he opened; for having diſſected him at an inconvenient diſtance of time from the dog's repaſt, the ſlender veſſels he looked for being deſtitute of the chyle, which is it, that makes them conſpicuous, did not appear. So that he had loſt the benefit of his firſt lucky obſervation, had not his ſagacity inclined him to ſuſpect, that if a dog was plentifully fed at a convenient diſtance of time before his being diſſected, the veſſel ſwelled with alimental juices would be the better diſcernible: whereupon, having feaſted another dog ſome hours before he opened him, he manifeſtly detected thoſe milky veſſels, whoſe diſcovery has ſince ſet anatomiſts ſo uſefully on work.

BUT, *Pyrophilus*, not to exceed the limits of an eſſay, I muſt not multiply inſtances of the contingencies of experiments, but content my ſelf to tell you in general, that in divers caſes ſuch circumſtances as are very difficult to be obſerved, or ſeem to be of no concernment to an experiment, may yet have a great influence on the event of it. If on either of the extremes or poles of a good armed load-ſtone, you leiſurely enough, or divers times, draw the back of a knife, which has not before received any magick influence, you may obſerve, that if the point of the blade have in this affriction been drawn from the middle of the æquator of the load-ſtone towards the pole of it, it will attract one of the extremes of an equilibrated magnetick needle; but if you take another knife, that has not been invigorated, and upon the ſelf-ſame extremity or pole of the load-ſtone thruſt the back of the knife from the pole towards the æquator, or middle of the load-ſtone, you ſhall find, that the point of the knife has, by this bare difference of poſition in the blade, whilſt it paſt upon the extreme of the load-ſtone, acquired ſo different a magnetick property, or polarity, from that, which was given to the former knife by the ſame pole of the load-ſtone, that it will not attract, but rather ſeem to repel or drive away that end of the magnetick needle, which was drawn by the point of the other knife. And this improbable experiment not only we have made

made trial of, by paſſing ſlender irons upon the extremities of armed load-ſtones, the breadth of whoſe ſteel-caps may make the experiment ſomewhat leſs ſtrange; but we have likewiſe tried it by affrictions of ſuch irons upon the pole of a naked terella, and we found it to ſucceed there likewiſe: how ſtrange ſoever it may ſeem, that the ſame point or part of the load-ſtone ſhould imbue iron with contrary properties, barely as they are, during their paſſing over it, drawn from the æquator of the load-ſtone, or thruſt towards it. But whether, or how far this obſervation inſinuates the operation of the load-ſtone to be chiefly performed by ſtreams of ſmall particles, which perpetually iſſuing out of one of its poles do wheel about and re-enter at the other; we ſhall not now examine, (though this ſeem one of the moſt likely phænomena we have met with, to hint a probable magnetical hypotheſis) contenting ourſelves to have manifeſted by what plainly appears, how much influence a circumſtance, which none but a magnetick philoſopher would take notice of, may have on an experiment. We have alſo, with pleaſure, obſerved, how artificers in the tempering of ſteel, by holding it but a minute or two longer or leſſer in the flame, (or other competent heat) do give it very differing tempers, as to brittleneſs or toughneſs, hardneſs or ſoftneſs: for as when it is taken out of the flame to be extinguiſhed, it looks either red, yellow or blue: ſo they eſteem and find it fit to make knives, engraving tools, or ſprings for watches, *&c.* and yet it paſſes from one colour to another ſo ſwiftly, that none but an artiſt expert in tempering of iron would ſuſpect, that ſo ſmall a difference of time of its ſtay in the flame could produce ſo great a difference in its tempers. On which occaſion, *Pyrophilus*, I call to mind, that making a while ſince ſome trials concerning gravers in the ſhop of a famous artificer, he preſented me, as a great rarity, a graver (which I yet keep) that would make the uſual experiments about tempering of gravers appear falſe to him, that ſhould never try them but upon it; for with all the care, wherewith I tried upon it the known ways of ſoftening gravers, I could not ſoften this: which men eminently ſkilled in theſe matters (together with the perſon, that made it) affirmed to have been made of *Damaſco*-ſteel, the ſtrength whereof in cutting iron I have (not without ſome wonder) made trial of. But whether this ſingularity, which we have mentioned in this graver, proceeded from the nature of the ſteel, or from the temper, that it had afterward given it, is not yet agreed upon by thoſe ſkilful men, to whom I have ſhewed it: but one of them, who by making inſtruments for navigators, has had the opportunity of making more than ordinary inquiry into matters of this nature, aſſures me, that he can eaſily ſoften this kind of ſteel, by only taking it off the fire at a certain nick of time, differing from that, which is wont to be obſerved in order to the ſoftening of common gravers. And who knows, but that in many other experiments, ſeemingly deſpicable and unheeded circumſtances may be of great concernment, though by reaſon of the want of ſuch particular obſervations, as the frequent dealing with the ſame body has given magnetick philoſophers and artificers occaſion to make, men have not yet taken notice of their importance?

To give you one inſtance to this purpoſe, *Pyrophilus*, let me take notice to you, that divers planters of fruit-trees have with wonder obſerved, that ſome grafts of cherry-trees, for example, have borne fruit the ſame year, that they were grafted, (nay, I have obſerved ſome plants to bear fruit the ſame quarter of the year) and others not till the year after their inſition, though neither in the goodneſs of the graft, nor in that of the ſtock, they had obſerved any diſparity, to which the difference above mentioned could be aſcribed; and therefore the bearing or not bearing of the cions of a cherry-tree the firſt year of its inſition is by many gardeners looked upon as a thing meerly contingent. And yet indeed it ſcarce deſerves to be reckoned among ſuch contingent experiments, as we have been hitherto treating of; for I am informed by the trials of more than one of the moſt ſkilful and experienced grafters of theſe parts, that a man ſhall ſeldom fail of having cherries borne by his graft the ſame year, in which the inſition is made, if he take care, that his graft, which muſt be of a good kind, have bloſſom-buds, as they are wont to be called, upon it: whereas if it were only leaf-buds, as they may be termed, it will not bear fruit till the ſecond ſeaſon. And this not being taken notice of by vulgar gardeners, makes them, as we have ſaid, impute a needleſs contingency to the fruitfulneſs of ſuch kind of grafts. Now to diſcern ſuch buds as are fit to produce bloſſoms, from ſuch as will diſplay themſelves but in leaves, is no difficult matter, the former ſort being more full, and big, and round than the latter, which are wont alſo to lie more flat and cloſe to the graft. And it was, *Pyrophilus*, ſuch obſervations as this, that induced us, after the beginning of the former eſſays, to diſcriminate from ſuch contingent experiments as thoſe, wherein the cauſe of the contingency is very abſtruſe and difficult to be diſcerned, ſuch other experiments, whoſe ſeeming contingency proceeds from more eaſily diſcoverable cauſes; for ſuch, by diligent obſervation of circumſtances, may be reduced to a greater certainty than the others ſeem capable of. Though I dare not deny, that even divers of thoſe contingent experiments, which to us yet ſeem to belong to the firſt ſort, by men's future ſkill and diligence in obſervation, may be made fit to be reduced to the ſecond ſort.

BEFORE I leave this ſubject, *Pyrophilus*, I dare not omit to ſay ſomething to you of the *Virgula Divina*, or rather *Divinatoria*, by which many mineraliſts pretend to diſcover the latent veins of metals. Some uſe a forked hazel, whoſe horns they hold by the ends one in each hand; and others content themſelves to chuſe a hazel rod (which ſome will have to be all of the ſame year's ſhoot) and this they bind on to another ſtreight ſtick of any other wood, and walking ſoftly with it over thoſe places, where they ſuſpect the bowels of the earth to be enriched

riched with metals, they ſay, that if they paſs over a metalline vein, the wand will, by bowing towards it, diſcover it. And ſome dealers in metals I know, who affirm, that by holding the metals ſucceſſively in that hand, wherein a man holds the rod, he may diſcover what determinate metal is predominant in the vein: for when he puts into his hand that metal, wherewith the mine chiefly abounds, the wand will manifeſtly bow more ſtrongly, than when it is held in the hand with any other metal. What to determine concerning the truth of this perplexing experiment, I confeſs I know not. For *Agricola* himſelf, after a long debate concerning it, gives us this account of his ſenſe; *Metallicus igitur* (ſays he) *quia eum virum bonum & gravem eſſe volumus, virgulâ incantatâ non utetur, quia rerum naturæ peritum & prudentem, furcatam ſibi uſui non eſſe, ſed, ut ſupra dixi, habet naturalia venarum ſigna, quæ obſervat.* The diligent *Kircherus* informs us in his *Arte Magneticâ*, that having exactly tried the experiment with metals, (for he mentions not his having tried it with mines,) he could not find it in any meaſure ſucceed; and we our ſelves having ſeveral times made trial of it in the preſence of the confidenteſt aſſertors of the truth of it, could not ſatisfy our ſelves, that the wand did really ſtand either to the metals, when placed under it, or to the metalline veins, when we carried it over mines, whence metalline ore was at that very time digging out. But on the other ſide, divers good authors, and even our diligent country-man *Gabriel Plat*, though wont to be ſomewhat too ſevere to chymiſts, does aſcribe very much to this detecting wand; and divers perſons, in other things very far from credulous, have as eye-witneſſes with great aſſeverations aſſerted the truth of the experiment before us: and one gentleman, who lives near the lead-mines in *Somerſetſhire*, leading me over thoſe parts of the mines, where we knew that metalline veins did run, made me take notice of the ſtooping of the wand, when he paſſed over a vein of ore, and proteſted, that the motion of his hand did not at all contribute to the inclination of the rod, but that ſometimes, when he held it very faſt, it would bend ſo ſtrongly as to break in his hand. And to convince me, that he believed himſelf, he did, upon the promiſes made him by his ſtooping wand, put himſelf to the great charge of digging in untried places for mines, (but with what ſucceſs he has not yet informed me.) Among the miners themſelves I found ſome made uſe of this wand, and others laughed at it. And this I muſt take notice of, as peculiar to this experiment, that the moſt knowing patrons of it confeſs, that in ſome men's hands it will not at all ſucceed, ſome hidden property in him that uſes the wand being able, as they ſay, to overpower and hinder its inclinatory virtue. To which I muſt add what a very famous chymiſt, who affirms himſelf to have tried many other things with it beſides thoſe that are commonly known, very ſolemnly profeſſed to me upon his own knowledge; namely, that in the hands of thoſe very perſons, in whoſe hands the rod will (as they ſpeak) work, there are certain unlucky hours, governed by ſuch planets and conſtellations, (which I confeſs I believed not enough to remember their names) during which it will not work, even in thoſe hands, wherein at other times it manifeſtly will. But of this experiment I muſt content my ſelf to ſay, what I am wont to do, when my opinion is aſked of thoſe things, which I dare not peremptorily reject, and yet am not convinced of; namely, that they that have ſeen them can much more reaſonably believe them, than they that have not.

De re metallica, lib. 20. p. 28.

Lib. 3. part 5. cap. 3.

NOR is it only in experiments, *Pyrophilus*, but in obſervations alſo, that much of contingency may be: witneſs the great variety in the number, magnitude, poſition, figure, *&c.* of the parts taken notice of by anatomical writers in their diſſections of that one ſubject the human body, about which many errors would have been delivered by anatomiſts, if the frequency of diſſections had not enabled them to diſcern betwixt thoſe things, that are generally and uniformly found in diſſected bodies, and thoſe which are but rarely, and (if I may ſo ſpeak) through ſome wantonneſs, or other deviation of nature, to be met with. I remember, that a while ſince being preſent at the diſſection of a luſty young thief, we had opportunity to obſerve, among other things, that the interval betwixt two of his ribs was near the back bone filled up with a thick bony ſubſtance, which ſeemed to be but an expanſion of the ribs, and appeared not to have grown there upon occaſion of any fracture, or other miſchance. About the ſame time being at a private diſſection of a large and young human body with ſome learned men, an ingenious perſon, profeſſor of anatomy, there preſent, chancing to cut a great nerve, ſpied in the ſubſtance of it a little of a very red liquor, which he immediately ſhewed me, as wondering what it might be: but I concluding it to be blood, preſently ſuſpected, that it might have proceeded from ſome ſmall unheeded drop of blood wiped off by the bruſhy ſubſtance of the nerve from the knife, wherewith it was cut. Wherefore carefully wiping a diſſected knife, I did in another place cut the nerve aſunder, and found another very little drop of pure blood in the ſubſtance of it as before. This I did again elſewhere with like ſucceſs, ſhewing it to the by-ſtanders, who admired to ſee a veſſel carrying blood (for ſuch they concluded it to be) in the body of a nerve, in regard they remembered not to have ever met with ſuch an accident; though I the leſs admire it, becauſe I have in an ox's eye or two obſerved in that coat, which the moderns commonly call the retina, and which ſeems to be but an expanſion of the pith of the optick nerve, little turgent veins manifeſtly full of blood.

WE further obſerved in that lately-mentioned body, in which we took notice of the irregular conjunction of two ribs, that the lungs, which were very ſound, had a ſupernumerary lobe on one ſide, which did ſo little differ from its companions, that we did not, till we had diſplayed the lungs, take notice of

it. And I remember, that a while before, being invited by a company of phyſicians to a private diſſection, and the lungs, which otherwiſe ſeemed not unſound, appearing in divers places faſtened to the ribs, two ingenious anatomiſts, that were there preſent, did ſo little agree in their obſervations concerning ſuch caſes, that the one affirmed, that he had never ſeen any lungs (which had not been exceſſively morbid) tied to the thorax; and the other proteſted, that he had ſcarce ever opened a diſeaſed body, wherein the lungs did not ſo adhere. But if it were not improper to mind a young gentleman of venereal obſervations, I could eaſily give you an eminent proof of the diſagreement of anatomical obſervators, by inſiſting on the controverſy betwixt the famous writers on that ſubject, concerning the anatomical notes or tokens of virginity; many eminent authors affirming, that they have ſeldom failed of finding them in one amongſt very many diſſected maids; and many other artiſts, both conſpicuous and experienced, preremptorily profeſſing, that they have ſeldom or never met with the pretended marks in perſons even of the moſt undoubted virginity. And certainly it is very ſtrange, that about a matter, which ſeems ſo eaſily determinable by ſenſe, accurate and ſober men ſhould ſo widely diſagree; as that the one ſhould profeſs he has very rarely, if ever, met with in a human body, what another affirmeth himſelf to have as ſeldom, if ever, miſſed. But becauſe, *Pyrophilus*, this ſubject is, perhaps, ſomewhat improper to be inſiſted on either to, or by, a young man, I ſhall paſs on to tell you, that amongſt the accurateſt of our modern writers, I ſuppoſe you will readily allow me to reckon Dr. *Harvey* and Dr. *Highmore*; and that though in their excellent treatiſes of generation they both inſiſt on the production and changes obſervable in hens eggs, as the patterns, whereunto the generation of other animals may be referred; yet have we divers, times, in the progreſs of nature in her formation of a chick, obſerved conſiderable variations in point of time and other circumſtances (though in the main our obſervations commonly agreed) from what is by them delivered: which diverſity may eaſily proceed from the differing conſtitution of hens, their differing aſſiduity in ſitting on their eggs, the differing qualifications of the eggs themſelves, and ſeveral other particulars of like nature. And I remember, that the other day taking notice of this to my learned friend Dr. *Highmore*, he readily acknowledged to me, that he himſelf had likewiſe obſerved divers circumſtances in eggs whilſt they were hatching, which varied from thoſe ſet down by him in his book; though he had there accurately expreſſed the changes he diſcerned in thoſe eggs, which at the ſame time afforded him his obſervations. And indeed there are certain things of ſuch a nature, that ſcarce any ſingle man's accurateneſs in making a ſingle obſervation about them can ſecure him from appearing unſkilful or unfaithful in his obſervations, unleſs thoſe, that ſhall afterwards examine them, chance to be endowed with a ſomewhat more than ordinary either equity, or ſagacity, or both. For inſtance, he that firſt affirmed, that a needle animated by a loadſtone did conſtantly convert its extremes to the oppoſite poles of the earth, could ſcarce ſuſpect himſelf of having delivered any thing, which he had not carefully tried. And yet of thoſe pilots, *Gonzales Oviedo* and *Sebaſtian Cabot*, (who are ſaid to have in *America* firſt taken notice of the declination of the mariner's needle) he that did firſt in thoſe far diſtant parts of the world compare the meridian line afforded by magnetical needles with one mathematically drawn, (which may be readily found by accurate ſun-dials,) and thereby obſerve the variation of the needle, or its declination from the true meridian line, might eaſily conclude the obſerver formerly mentioned to have been faulty, by reaſon of his finding the needle's variation differing (perhaps by divers degrees) from that delivered by the firſt obſerver. And this ſecond man's obſervation might appear to have been as careleſly made to a hundred other obſervers, if the obſervations of navigators had not made it apparent, that the declination of the needle is far from being the ſame in all places: for though *Cardan* (as *Kircher* and *Fracaſtorius*, as another informs us) be pleaſed to affirm, that the loadſtone declines as many degrees, as the pole-ſtar is diſtant from the pole of the world; yet beſides divers reaſons, common experience ſufficiently manifeſts the inconſiderableneſs (not to ſpeak more harſhly) of that aſſertion. For about the iſlands of the *Azores*, eſpecially that of *Corvo*, over which the firſt meridian is by many ſuppoſed to paſs, the magnetick needle hath been obſerved directly to reſpect the poles, without any ſenſible declination from them; but in other places it is wont to vary ſometimes eaſtward, ſometimes weſtward, more or leſs. Inſomuch that not only our venturous countryman Captain *Thomas James* obſerved it in 63 degrees north-latitude to be no leſs than 27 degrees, 48 minutes; but a learned mathematical writer, that is lately come forth, makes the declination at the *Fretum Davis* to amount to, what is almoſt incredible, 50 degrees. And this deflexion of the needle ſometimes to one ſide of the meridian, ſometimes to the other, happens with ſo much ſeeming irregularity, as has made both the diligent *Kircher* himſelf, and divers other magnetick writers, almoſt deſpair of reducing theſe kind of obſervations to any general hypotheſis.

Fourn'er Hydr. l. 11. *c.* 11.

In the Table annexed to his voyage.

To which we may add, that perhaps very few even of the exacteſt obſervations of this nature made an age ſince, would now appear accurate to them, that ſhould try them in the ſelf-ſame places wherein, and the ſelf ſame manner after which they were formerly made. So that the diligenteſt of thoſe obſervers would appear to us to have been negligent, if the ſagacity of ſome of their ſucceeders had not prompted them to ſuſpect, that even in the ſame place the needle's variation may vary. And I remember, that having not long ſince inquired of an Engliſh contriver of mathematical inſtruments for the uſe of ſeamen, what he had obſerved concerning this alteration of the needle's

variation, he told me, that by comparing of ancient and modern obſervations made by himſelf and other accurate mathematicians at *London*, he had found the declination conſtantly to decreaſe, and, as he conjectured, about 12 or 13 minutes (though that methinks be much) in a year. And it will be yet more difficult to ſet down any obſervation of this nature, which will appear exact to poſterity, if that ſtrange thing be true (as it may well be) which was related to *Kircher* by a friend of his, who affirms himſelf to have obſerved a notable change of the needle's variation at *Naples*, after a great *incendium* of the neighbouring mountain *Veſuvius*; which alteration he not abſurdly ſuſpects to have proceeded from the very great change made in the neighbouring ſubterraneal parts by that great conflagration. And it ſeems the ſame obſervation has been taken notice of by mathematicians elſewhere. For the learned Jeſuit *Fournier* in his French hydrography tells us in more general terms, that ſince the *incendiums* of *Veſuvius* the declination (of the needle) has notably changed in the kingdom of *Naples*. The ſame author ſomewhere delivers what (if it be true) is remarkable to our preſent purpoſe, in theſe words: 'There are perſons, who have obſerved, that the 'ſame needle, that declined 5 degrees upon the 'ſurface of the earth, being carried down very 'low into certain caves, declined quite other-'wiſe.' I added thoſe words, *if it be true*, not to queſtion the veracity of the author, but becauſe it is very poſſible the makers of the obſervation (though learned men) may have been miſtaken in it, without ſuſpecting themſelves in danger of being ſo. For I ſhould ſcarce have imagined, unleſs my own particular obſervation had informed me, in how great a variety of ſtones and other foſſiles the ore of iron may lurk diſguiſed: ſo that it is no way incredible, that knowing chymiſts themſelves, and much more mathematicians and others, not being aware of the obſervation of what I have newly delivered, may preſume, becauſe they ſaw not in the deep caves above mentioned any minerals like the vulgar iron ore, that there is nothing of that metal there, when indeed there may be enough to occaſion that deflexion of the needle; which (eſpecially if it be ſtrongly excited) may be often drawn aſide by iron or other magnetick bodies, at a greater diſtance than thoſe, that have not tried, will be apt to ſuſpect. Which may perhaps be the reaſon, why in the little iſland of *Ilva* (upon the coaſt of *Italy*) where they dig up iron and ſtore of loadſtones, of which I have ſeen in *Tuſcany* of a prodigious bigneſs, there is in different, but neighbouring places, ſuch a ſtrange diſparity of the needle's variation as curious men have recorded.

Book II. *chap.* 10.

NOR are magnetical and anatomical obſervations the only ones, which are ſubject to diſagree now and then, without the negligence of thoſe that make them: but I want time, and I fear you would want patience, to conſider at preſent as many of them, as might be eaſily enumerated to you.

I SUPPOSE, *Pyrophilus*, you may have obſerved, how I in the paſt diſcourſe have forborn to inſiſt on medicinal experiments; which I have purpoſely done, becauſe they are ſo many, and almoſt all of them ſubject to ſuch uncertainties, that to inſiſt on them would require much more time, than my occaſions will allow me to ſpend upon this eſſay. And indeed in phyſick it is much more difficult than moſt men can imagine, to make an accurate experiment: for oftentimes the ſame diſeaſe proceeding in ſeveral perſons from quite differing cauſes, will be increaſed in one by the ſame remedy by which it has been cured in another. And not only the conſtitutions of patients may as much alter the effects of remedies, as the cauſes of diſeaſes; but even in the ſame patient, and the ſame diſeaſe, the ſingle circumſtance of time may have almoſt as great an operation upon the ſucceſs of a medicine, as either of the two former particulars; as we may elſewhere have occaſion by ſundry inſtances to manifeſt. But beſides the general uncertainty, to which moſt remedies are ſubject, there are ſome few, that ſeem obnoxious to contingencies of a peculiar nature: ſuch is the ſympathetick powder, of which not only divers phyſicians and other ſober perſons have aſſured me they had ſucceſsfully made trial, but we our ſelves have thought, that we were eye-witneſſes of the operation of it; and yet not only many, that have tried it, have not found it anſwer expectation, but we our ſelves trying ſome of our own preparing on our ſelves, have found it ineffectual, and unable to ſtop ſo much as a bleeding at the noſe; though upon application of it a little before, we had ſeen ſuch a bleeding, though violent, ſuddenly ſtopped in a perſon, who was ſo far from contributing by his imagination to the effect of the powder, that he derided thoſe, that he ſaw apply it to ſome of the drops of his blood. Wherefore that the ſympathetick powder and the weapon-ſalve are never of any efficacy at all, I dare not affirm; but that they conſtantly perform what is promiſed of them, I muſt leave others to believe. But making mention of remedies of this nature, though I am willing, *Pyrophilus*, to put a period both to your trouble and my own, yet I muſt not omit to tell you, that whereas the pæony-root has been much commended both by ancient and modern phyſicians of no mean account, as an amulet againſt the falling-ſickneſs, and yet has been by many found ineffectual; we have been apt to ſuſpect, that its inefficacy, if it be but infrequent, might poſſibly proceed from its having been unſeaſonably gathered: and when I was laſt in the weſt of *Ireland*, acquainting the eminenteſt of the Galeniſts there with my conjecture, he confirmed me in it, by aſſuring me, that he had often tried the pæony-root unſeaſonably gathered without ſucceſs; but having lately gathered it under its proper conſtellation, as they ſpeak, (which is when the decreaſing moon paſſes under *Aries*) and tied the ſlit root about the necks and arms of his patients, he had freed more than one, whom he named to me, from epileptical fits. Agreeable whereunto I find, that a famous phyſician of *Grenoble*, Monſieur *des Grands Prez*, in the laſt of his obſervations

communicated to the famous practical phyſician *Riverius*, ſolemnly profeſſes his having divers times freed his patients from the falling-ſickneſs by the ſingle outward application of pæony-roots, collected and applied as is above-mentioned. But though he thence infers the uſefulneſs of obſerving ſtars in the practice of phyſick, yet before much weight be laid upon ſuch improbable notions, as moſt of thoſe of judiciary aſtrologers, the influence of conſtellations upon ſimples, *&c.* ought by ſevere and competent experiments to be better made out than hitherto it has been.

But to ſay no more of the contingent obſervations to be taken notice of in trials medical, I could tell you, that I have obſerved even mathematical writers themſelves to deliver ſuch obſervations as do not regularly hold true. For though it hath been looked upon as their privilege and glory to affirm nothing, but what they can prove by no leſs than demonſtration; and though they uſed to be more attentive and exact, than moſt other men in making almoſt any kind of philoſophical obſervation: yet the certainty and accurateneſs, which is attributed to what they deliver, muſt be reſtrained to what they teach concerning thoſe purely-mathematical diſciplines, arithmetick and geometry, where the affections of quantity are abſtractedly conſidered: but we muſt not expect from mathematicians the ſame accurateneſs, when they deliver obſervations concerning ſuch things, wherein it is not only quantity and figure, but matter, and its other affections, that muſt be conſidered. And yet leſs muſt this be expected, when they deliver ſuch obſervations, as, being made by the help of material inſtruments framed by the hands and tools of men, cannot but in divers caſes be ſubject to ſome, if not many, imperfections upon their account. Divers of the modern aſtronomers have ſo written of the ſpots and more ſhining parts or (as they call them) *Faculæ*, that appear upon or about the ſurface of the ſun, as to make their readers preſume, that at leaſt ſome of them are almoſt always to be ſeen there. And I am willing to think, that it was their having ſo often met with ſuch phænomena in the ſun, that made them write as they did. And yet when I firſt applied my ſelf to the contemplation of theſe late diſcoveries, though I wanted neither good teleſcopes, nor a dark room to bring the ſpecies of the ſun into, yet it was not till after a great while, and a multitude of fruitleſs obſervations made at ſeveral times, that I could detect any of theſe ſolary ſpots, which having during many months at leaſt appeared ſo much ſeldomer than it ſeems they did before, that I remember a moſt ingenious profeſſor of aſtronomy, excellently well furniſhed with dioptrical glaſſes, did about that time complain to me, that for I know not how long he had not been able to ſee the ſun ſpotted. And as for the *Faculæ*, that are written of, as ſuch ordinary phænomena, I muſt profeſs to you, *Pyrophilus*, that a multitude of obſervations made with good teleſcopes, at ſeveral places and times whilſt the ſun was ſpotted, has ſcarce made me ſee above once any of the looked for brightneſſes.

And as the nature of the material objects, wherewith the mathematician is converſant, may thus deceive the expectations grounded on what he delivers; ſo may the like happen by reaſon of the imperfection of the inſtruments, which he muſt make uſe of in the ſenſible obſervations, whereon the mixed mathematicks (as aſtronomy, geography, opticks, *&c.*) are in great part built. This is but too manifeſt in the diſagreeing ſupputations, that famous writers, as well modern as ancient, have given us of the circuit of the terreſtrial globe, of the diſtance and bigneſs of the fixed ſtars and ſome of the planets, nay, and of the height of mountains: which diſagreement, as it may oftentimes proceed from the differing method and unequal ſkill of the ſeveral obſervers, ſo it may in divers caſes be imputed to the greater or leſs exactneſs and manageableneſs of the inſtruments employed by them. And on this occaſion I cannot omit that ſober confeſſion and advertiſement, that I met with in the noble *Tycho*, who having laid out, beſides his time and induſtry, much greater ſums of money on inſtruments than, any man we have heard of in latter times, deſerves to be liſtened to on this theme, concerning which he has (among other things) the following paſſage: *Facilè* (ſays he) *lapſus aliquis penè inſenſibilis in inſtrumentis etiam majoribus conficiendis ſubrepit, qui inter obſervandum aliquot ſcrupulorum primorum jacturam faciat; inſuper ſi ipſe ſitus & tractandi modus non tam abſoluta norma perficiatur, ut nihil prorſus deſideretur, intolerabilis nec facilè animadvertenda deviatio ſeſe inſinuat. Adde quod inſtrumenta uſu & ætate à prima perfectione degenerent. Nihil enim, quod hominum manibus paratur, ab omni mutatione undiquaque exiſtit. Organa enim ejuſcemodi, niſi è ſolido metallo affabre elaborentur, mutationi aëreæ obnoxia ſunt; & ſi id quoque detur, ut è metallica materia conſtent, niſi ingentia fuerint, diviſiones minutiſſimas graduum non ſufficienter exhibent; dumque hoc præſtant, ſua magnitudine & pondere ſe ipſa ita aggravant, ut facile tum extra planum debitum aut figuram competentem, dum circumducuntur, declinent, tum etiam ſua mole intractabilia redduntur. Quare magis requiritur in inſtrumentis aſtronomicis, quæ omni vitio careant conſtruendis, artificium pari judicio conjunctum, quam hactenus à quamplurimis animadverſum eſt. Id quod nos ipſe uſus longaque docuit experientia, non parvo labore nec mediocribus ſumptibus comparata.*

Tycho Brahe, *l.* 2. *de Cometâ An.* 1577. *p.* 133.

Hitherto our noble author. And as for the obſervations made at ſea, the diligent *Fournier* advertiſes, that however many ſea-captains and others may brag of their mathematical obſervations made on ſhip-board, yet he, upon trial of many inſtruments both at ſea and aſhore, makes bold to affirm, that no aſtronomer in the world can be ſure to make his obſervation at ſea within ten minutes of the preciſe truth, no not (ſays he) upon the ſand it ſelf, within one minute of it.

But inſtead of acquainting you with what may be drawn from the writings of our hydrographer,

grapher, to prove, that his aſſertion is rather modeſt than too bold, I ſhall obſerve, that the obſervations even of ſkilful mathematicians may hold ſo little, or diſagree ſo much, when they pretend to give us the determinate meaſures of things, that I remember of three very eminent modern mathematicians, who have taken upon them, by their experiments, to determine the proportion betwixt air and water, the one makes not the weight of water to exceed above 150 times that of air; the other reckons water to be between 13 and 14 hundred times; and the third no leſs than 10,000 times the heavier. Not to mention a modern and famous writer or two, who have been ſo miſtaken as to think, that the weight of the water in compariſon of the air is I know not how much under-reckoned, even by this laſt (overbold) eſtimate. And, if I had leiſure, I could annex an experiment partly ſtatical, and relating to the weight of the air, which though we made divers times in an hour, yet we miſſed of the like ſucceſs twice as often in the ſame hour, without being able to know before-hand, whether the experiment would ſucceed within ſome pounds weight. But of this more perhaps elſewhere.

THE ends, *Pyrophilus*, which we have propoſed to our ſelves in ſetting down the things by us delivered in this and the former eſſay, are principally two.

AND firſt, we deſire, that the inſtances we have given you of the contingency of experiments, may make you think your ſelf obliged to try thoſe experiments very carefully, and more than once, upon which you mean to build conſiderable ſuperſtructures either theorical or practical; and to think it unſafe to rely too much upon ſingle experiments, eſpecially when you have to deal in minerals: for many to their ruin have found, that what they at firſt looked upon as a happy mineral experiment, has proved in the iſſue the moſt unfortunate they ever made. And I remember, that the moſt experienced mineraliſt I have hitherto been acquainted with, though his ſkill has been rather gainful then prejudicial to him, has very ſeriouſly told me, that he could quickly grow an extraordinary rich man, if he could but do conſtantly whatſoever he has done, not only two or three, but many times.

THE other end, *Pyrophilus*, to which I had an eye in writing the paſt diſcourſes, was, that they may ſerve for a kind of apology for ſober and experimental writers, in caſe you ſhould not always upon trial find the experiments or obſervations by them delivered anſwer your expectations. And indeed it would prove a great diſcouragement to wary and conſiderate naturaliſts from enriching the world with their obſervations, if they ſhould find, that their faithfulneſs in ſetting down what they obſerved is not able to protect them from blaſting imputations of falſhood, but that by publiſhing any thing for the good of others, they muſt expoſe their reputation to all the uncertainties, to which any of their experiments may chance to prove obnoxious. It is true indeed, that if a writer be wont to be fabulous or tranſcriptive, and to deliver things confidently by hear-ſay, without telling his readers when he does ſo; if his experiments upon trial ſucceed not, we may be allowed to impute their unſucceſsfulneſs rather to him, than to our ſelves, or to chance, and need not think our ſelves obliged to have ſo much a greater care of his reputation, than he had of his own, as for his ſake to try more than once, what he for our ſakes never tried ſo much as once. But if an author, that is wont to deliver things upon his own knowledge, and ſhews himſelf careful not to be deceived, and unwilling to deceive his readers, ſhall deliver any thing, as having tried or ſeen it, which yet agrees not with our trials of it; I think it but a piece of equity, becoming both a Chriſtian and a philoſopher, to think (unleſs we have ſome manifeſt reaſon to the contrary) that he ſet down his experiment or obſervation as he made it, though for ſome latent reaſon it does not conſtantly hold; and that therefore though his experiment be not to be relied upon, yet his ſincerity is not to be rejected. Nay, if the author be ſuch an one, as has intentionally and really deſerved well of mankind, for my part I can be ſo grateful to him, as not only to forbear to diſtruſt his veracity, as if he had not done or ſeen what he ſays he did or ſaw, but to forbear to reject his experiments, till I have tried, whether or no by ſome change of circumſtances they may not be brought to ſucceed. Thus a while ſince finding in Sir *Francis Bacon*, that he delivers as a ſomewhat unlikely truth, that ſpirit of wine will ſwim upon oil (of almonds) we forthwith made trial of it, but found the oil ſwim upon the ſpirit of wine, and this upon ſeveral trials before witneſſes: but our tenderneſs of the reputation of ſo great and ſo candid a philoſopher made us to bethink our ſelves, that (though he mentions it not, nor perhaps thought of any ſuch thing, yet) poſſibly he may have uſed ſpirit of wine more pure than ordinary; and thereupon having provided ſome that was well rectified, we found, that the oil, that was wont to ſwim upon ſpirit of wine, not freed from its aqueous parts, did readily ſink, and quietly lie in the bottom of that, which was carefully dephlegmed. And ſo having been informed, that the learned Dr. *Brown* ſomewhere delivers, that aqua fortis will quickly coagulate common oil, we poured ſome of thoſe liquors together, and let them ſtand for a conſiderable ſpace of time in an open veſſel, without finding in the oil the change by him promiſed, (though we have more than once with another liquor preſently thickened common oil.) Whereupon being unwilling, that ſo faithful and candid a naturaliſt ſhould appear fit to be diſtruſted, we did again make the trial with freſh oil and aqua fortis in a long-necked phial left open at the top, which we kept both in a cool place, and after in a digeſting furnace; but after ſome weeks we found no other alteration in the oil, than that it had acquired a high and lovely tincture: notwithſtanding which, being ſtill concerned for the reputation of a perſon, that ſo well deſerves a good one, the like contingencies we have

formerly

formerly met with in other experiments, made us willing to try, whether or no the unſucceſsfulneſs we have related might not proceed from ſome peculiar though latent quality, either in the aqua fortis or the oil by us formerly employed: whereupon changing thoſe liquors, and repeating the experiment, we found after ſome hours the oil coagulated almoſt into the form of a whitiſh butter. Nor dare I allow my ſelf to be confident, that I ſhall not need to be dealt with by you upon ſome occaſions, with the like equity, that I have been careful to expreſs towards others. And ſince the writing of thus much of this very eſſay, having deſired a very ſkilful and candid chymiſt to do me the favour to provide me ſome of the pureſt and ſtrongeſt ſpirit of ſalt, that could be made; he kept ſome ſalt in a vehement fire for divers days and nights together, and freed the extracted liquor ſo carefully and ſo ſkilfully both from its phlegm and its terreſtrial fæces, that after all I have written in the former eſſay concerning that menſtruum, I muſt freely confeſs to you, that I am now ſatisfied, that a ſpirit of ſea-ſalt may without any unſincerity be ſo prepared, as to diſſolve the body of crude gold, though I could not find, that the ſolutions I made of that metal were red, but rather of a yellow or golden colour, much like thoſe made with common aqua regis. But neither this artiſt nor I have been ſince able to make another ſpirit of ſalt capable of diſſolving gold, notwithſtanding all the induſtry we have employed about it; which makes me refer this to contingent experiments; unleſs the proſperous event of our former trial may be aſcribed to the quality of the ſalt, that was diſtilled, which was brought from the iſland of *Mayo*, where the ſcorching ſun makes out of the ſea-water a ſalt, that is accounted much ſtronger and more ſpirituous than that, which is wont to be made in *France* and other more temperate climates. And let me, *Pyrophilus*, take this opportunity to add, that if I had not very cautiouſly ſet down the obſervation I related in another eſſay * concerning the little fiſhes or worms I there teach you to diſcover in vinegar, I ſhould perhaps need much of your equity, to keep me from being thought to have impoſed upon you in what I there delivered. For I have ſince met with divers parcels of vinegar, wherein the obſervation could not be made, for one wherein it held; ſo that I am glad to keep by me ſome vinegar ſtocked with thoſe ſcarce viſible animals, to ſatisfy ingenious men, among whom ſome have been fain, after their own fruitleſs trials, to come to me to ſhow them the things delivered in that obſervation. What I mentioned a little above to have been tried upon ſallet-oil, puts me in mind of telling you, that among our experiments concerning the changes of colours, we were about to acquaint you with one, which we had formerly made upon common oil-olive, it ſeeming to us a not inconſiderable one; ſince it was a way, that we deviſed, of inſtantly changing the colour of the oil from a pale yellow to a deep red, with a few drops of a liquor, that was not red, but almoſt colourleſs. This experiment, as we were ſaying, *Pyrophilus*, we were about to ſet down among others concerning colours: but becauſe we do not willingly rely on a ſingle trial of ſuch things, as we know not to have been ever tried before, we thought it not amiſs for greater ſecurity to make the experiment the ſecond time, but could not then find it to ſucceed, nor even ſince upon a new trial (probably by reaſon of ſome peculiar quality in that particular parcel of liquor we firſt made uſe of) which made us think fit to omit the intended mention of it: but if I had upon my firſt trial acquainted you with it without any further ſcruple, you might upon trial have ſuſpected, if not concluded, that I had miſ-informed you, though I had really delivered nothing but what I had tried. And indeed, *Pyrophilus*, though I have not the vanity to pretend to have deſerved ſo much of you, as ſuch naturaliſts as Sir *Francis Bacon* have deſerved from every ingenious reader of their books; yet perhaps you will do me but right to believe, that though ſome of the experiments I have delivered may prove contingent, yet I have not delivered them unfaithfully, in reference to what I thought I obſerved in them, and remembered of them. And though I deſire you ſhould ſo read my writings, as to give no farther aſſent to my opinions, than the reaſons or experiments produced on their behalf require; yet in matters of fact, which I deliver as having tried or ſeen them, I am very willing you ſhould think, that I may have had the weakneſs to be miſtaken, but not an intention to deceive you.

THERE is yet one thing more, that I ſhall venture to acquaint you with before I conclude this eſſay, though you may think it reliſhes of a paradox, and it is this: that when I am ſatisfied of the abilities and circumſpection of a writer, delivering a matter of fact as upon his own knowledge; I do not preſently reject his obſervation as untrue, much leſs condemn the perſon himſelf as a lyar, whenſoever I find, that it ſeems to be contradicted by a contrary and more undoubted obſervation, or to contradict a received and plauſible either hypotheſis or tradition; but rather try, if by fit diſtinction or limitation I can reconcile them; unleſs I can imagine ſomething or other, which might probably lead him to miſtake. And of this indulgence to an intelligent writer I have this reaſon to give, that ſometimes there happen irregularities contrary to the uſual courſe of things, as is evident in monſters; and ſometimes the received hypotheſis, though perhaps not to be rejected as to the main, will not hold ſo univerſally as men preſume; and ſometimes too the contradiction betwixt the obſervations may be but ſeeming, (by reaſon of the want of ſome unheeded circumſtance neceſſary to make them inconſiſtent) and ſo they may both be true.

WE might dilucidate and confirm what we have newly delivered by ſeveral inſtances, were it not, that this eſſay is already but too prolix. Wherefore we ſhall only recommend to your conſideration theſe few particulars.

THAT the Iriſh ſpiders (of which, what-

* This is one of thoſe, that make up the book of the uſefulneſs of *Experimental Philoſophy*.

ever is vulgarly believed to the contrary, my ſelf have in *Ireland* ſeen divers) are not poiſonous, is not doubted by the inhabitants, who have had many ages experience of their harmleſſneſs: and yet I dare not deny what the learned *Scaliger* ſomewhere affirms, that in (his country, if I miſ-remember not) *Gaſcony* their venom is ſo pernicious, that they ſometimes poiſon thoſe that tread upon them through the very ſoles of their ſhoes. And that even here in *England* (though a country ſo near to *Ireland*) ſome ſpiders (at leaſt) are venomous even without biting, I may elſewhere have occaſion to give you an experimental proof.

IT is ſo much taken for granted by divers authors, who pretend likewiſe to give reaſons of it, and by the generality of their readers, that under the ſame meridian the magnetick needle keeps every where the ſame variation, without changing it by being carried northwards or ſouthwards, that it is like, if many perſons better acquainted with magnetick ſpeculations than trials ſhould read in the relations of the Hollanders, that under the meridian, that paſſes by the iſland of *Corvo*, where the needle points directly at the poles, and which is therefore wont to be reckoned the firſt meridian, they found at two places, the one about 46, the other about 55 degrees of northern latitude, a declination in the former of thoſe elevations of no leſs than 7 or 8 degrees, and in the latter of a far greater number; and alſo that they found under the twentieth parallel of ſouthern latitude under the ſame meridian of the *Azores* 10 or 11 degrees of declination; many, I ſay, if they ſhould meet with theſe particulars, probably would ſuppoſe the Dutch to have been very bad obſervers, becauſe theſe obſervations do not (as we intimated above) agree with the theory of the needle's declination. And yet if we confer theſe obſervations with others of the like nature, made by good navigators and other ſkilful men along other meridians, we may, I ſuppoſe, find cauſe rather to rectify the general opinion, than reject the Dutch obſervations for their diſagreeing with it; eſpecially if we take into conſideration what is affirmed by the Jeſuit *Jules Alenis* (whom *Fournier*, amply treating of longitudes, extols for the accurateſt obſerver of the needle's variation that ever was) ſailing into *China* in a great Portugal carraque, and accompanied by the famous pilot *Vincent Rodrique*, who had then made twenty-eight voyages to the *Indies*. For out of one of this father's letters *Fournier* has preſerved this memorable paſſage; 'You muſt (ſays he) take 'notice of one thing very conſiderable, name- 'ly, that the further you go from the æquator 'in the ſame meridian, the greater you will 'find the magnetical variation.' There are ſome eminent modern naturaliſts, who affirm, that they have aſſuredly tried by weather-glaſſes, that cellars and other ſubterraneal places are colder in winter than in ſummer: and yet not to oppoſe to this experiment the common tradition to the contrary, I remember, that the bold and induſtrious Capt. *James* (formerly mentioned) in the relation of his ſtrange voyage publiſhed by his late Majeſty's command, has this notable obſervation, where he relates the exceſſive coldneſs of the water they met with in ſummer in that icy region, where they were forced to winter in the year 1632. 'Moreover 'our well (ſays he) out of which we had wa- 'ter in *December*, had none in *July*.'

De la Longitude, c. 34.

LASTLY, Though in the weſtern parts it have been obſerved, that generally the inſide, or heart, as they call it, of trees, is harder than the outward parts; yet an author, very well verſed in ſuch matters, treating of the building of ſhips, gives it us for a very important advertiſement touching that matter, that they have obſerved at *Marſeilles*, and all along the Levantine ſhores, that that part of the wood, that is next the bark, is ſtronger than that, which makes the heart of the tree. But to draw at length to a concluſion of this already too tedious eſſay; the ends above mentioned, *Pyrophilus*, being thoſe, which I propoſed to my ſelf in writing the paſt diſcourſe, you will make an uſe of it, which I was very far from intending you ſhould, if you ſuffer it to diſcourage you from the vigorous proſecution of your inquiries into experimental knowledge. Nor indeed is any thing, that hath been ſaid, fit to perſuade you to other than watchfulneſs in obſerving experiments, and warineſs in relying on them; but not at all to ſuch a deſpondency of mind, as may make you forbear the proſecution of them: for neither doth the phyſician renounce his profeſſion, becauſe divers of the patients he ſtrives to cure are not freed from their diſeaſes by his medicines, but by death; nor doth the painful huſbandman forſake his cultivating of the ground, though ſometimes an unſeaſonable ſtorm or flood ſpoils his harveſt, and deprives him of the expected fruit of his long toils. For as in phyſick and huſbandry, thoſe, that exerciſe them, are kept from deſerting their profeſſions, by finding, that though they ſometimes miſs of their ends, yet they oftentimes attain them, and are by their ſucceſſes requited not only for thoſe endeavours that ſucceed, but for thoſe that were loſt; ſo ought we not by the contingencies incident to experimental attempts, to be deterred from making them, becauſe not only there are many experiments ſcarce ever obnoxious to caſualties, but even among thoſe, whoſe event is not ſo certain, you may very probably make an experiment very often, without meeting with any of thoſe unlucky accidents, which have the power to make ſuch experiments miſcarry. And ſure the proſperous ſucceſs of many ſucceeding attempts is well able to make amends for the fruitleſs pains employed on thoſe few, that ſucceed not; eſpecially ſince in experiments it not unfrequently happens, that even when we find not what we ſeek, we find ſomething as well worth ſeeking as what we miſſed. Of this laſt mentioned truth we may elſewhere have occaſion to diſcourſe more largely; and therefore ſhall now conclude with barely minding you, that even merchants themſelves are not wont to quit their profeſſion, becauſe now and then they loſe a veſſel at ſea, and oft-times their ſhips are by contrary winds and other accidents forced to put in at other ports than thoſe they were bound for. Which

Fourn. Architecture Navale, c. 22.

example

example I the rather make uſe of, becauſe that as the American navigators employed by the European merchants, having been by ſtorms forced from their intended courſe, have been ſometimes thereby driven upon unknown coaſts, and have made diſcovery of new regions much more advantageous to them, than the faireſt and conſtanteſt winds and weather could have been; ſo in philoſophical trials, thoſe unexpected accidents, that defeat our endeavours, do ſometimes caſt us upon new diſcoveries of much greater advantage, than the wonted and expected ſucceſs of the attempted experiment would have proved to us.

SOME

SPECIMENS of an Attempt

To make CHYMICAL EXPERIMENTS uſeful to illuſtrate the notions of the CORPUSCULAR PHILOSOPHY.

THE PREFACE,

Giving an account of the two following treatiſes, and propoſing the deſirableneſs of a good intelligence betwixt the Corpuſcularian Philoſophers and the Chymiſts.

THERE are many learned men, who being acquainted with chymiſtry but by report, have from the illiterateneſs, the arrogance and the impoſtures of too many of thoſe, that pretend ſkill in it, taken occaſion to entertain ſo ill an opinion, as well of the art, as of thoſe that profeſs it, that they are apt to repine, when they ſee any perſon, capable of ſucceeding in the ſtudy of ſolid philoſophy, addict himſelf to an art they judge ſo much below a philoſopher, and ſo unſerviceable to him: nay, there are ſome, that are troubled when they ſee a man, acquainted with other learning, countenance by his example ſooty empiricks, and a ſtudy, which they ſcarce think fit for any but ſuch, as are unfit for the rational and uſeful parts of phyſiology. I now take notice of theſe things, becauſe they gave occaſion to the two following treatiſes. For perceiving divers years ago, that ſome learned men of the temper above deſcribed thought it ſtrange (if not amiſs alſo) that one, of whoſe ſtudies they were pleaſed to have too favourable an expectation, ſhould ſpend upon chymical trials (to which I then happened to be invited by the opportunity of ſome furnaces and leiſure) much of thoſe endeavours, which they ſeemed to think might be far more uſefully employed, than upon ſuch an empty and deceitful ſtudy: perceiving this, I ſay, I thought it not amiſs to endeavour to manifeſt, that without ſeeking after the elixir, that alchymiſts generally hope and toil for, (but which they, that knew me, knew to be not at all in my aim) I did not in the proſecution of chymical trials do any thing either without an end, or unſuitable to the deſign I had of attempting to promote men's knowledge of the works of nature, as well as their power over them. In order to this, I did not think it enough to ſhew, that by an inſight into chymiſtry one may be enabled to make ſome meliorations (I ſpeak not of * tranſmutations) of mineral and metalline bodies, and many excellent medicines for the health of men, beſides divers other preparations of good uſe in particular trades, and in ſeveral occurrences of human life; I did not, I ſay, think it enough to do this, becauſe, that though this might ſuffice to evince that a rational man might without loſing his time employ ſome of it to underſtand and promote chymiſtry; yet this would ſcarce ſuffice to manifeſt it to be uſeful to philoſophy. And therefore there ſeemed requiſite ſome ſpecimens, which might ſhew that chymical experiments might be very aſſiſtant even to the ſpeculative naturaliſt in his contemplations and inquiries.

BUT againſt my attempting any thing of this nature, three difficulties oppoſed themſelves. The firſt was the want of leiſure, in regard I was already pre-engaged to write of other ſubjects, and to proſecute ſome experiments, whoſe event I was concerned to know. Another impediment was, that for other reaſons elſewhere mentioned, and chiefly to keep my judgment as unprepoſſeſſed as might be with any of the modern theories of philoſophy, till I were provided of experiments to help me to judge of them; I had purpoſely refrained from acquainting myſelf thoroughly with the intire ſyſtem of either the Atomical, or the Carteſian, or any other whether new or revived philoſophy; and therefore I could ſcarce be fit to ſhew, how chymical experiments might illuſtrate their doctrines. And thirdly, ſome of thoſe learned men, for whom I was to write, more favouring the Epicurean, and others (though but a few) being

* See the *Eſſay of the Uſefulneſs of Chymiſtry* in Sect. II. Part I. *Of the Uſefulneſs of E. P.*

being more inclinable to the Carteſian opinions, it ſeemed very difficult to gratify by the ſame compoſures perſons of differing perſuaſions.

But as to the firſt of theſe diſcouragements, ſince my pre-engagements to other themes were not unknown to thoſe, for whom I was to write, it might reaſonably be preſumed they would over-look ſuch unaccurateneſs as ſhould appear imputable to haſte: and beſides, ſome ſuch ſubject might be choſen to write of, as would conveniently admit enlargements and additions, according as my leiſure ſhould afterwards ſerve me to annex them.

On occaſion of the ſecond impediment, I remembered, that having divers years before read the lives of the Atomical, among other philoſophers, in *Diogenes Laertius*; and having ſometimes occaſionally heard mention made of divers Epicurean and Carteſian notions, and having hence framed to my ſelf ſome general, though but imperfect, idea of the way of philoſophizing my friends eſteemed; I thought I might, without a more particular explicit inquiry into it, ſay ſomething to illuſtrate ſome notions of it, by making choice of ſuch, as, being of the more ſimple and obvious, did not require ſkill in the more myſterious points of the hypotheſis they belonged to.

And as for the laſt of the three diſcouragements abovementioned, I conſidered, that the Atomical and Carteſian hypotheſes, though they differed in ſome material points from one another, yet in oppoſition to the Peripatetick and other vulgar doctrines they might be looked upon as one philoſophy: for they agree with one another, and differ from the ſchools in this grand and fundamental point, that not only they take care to explicate things intelligibly; but that whereas thoſe other philoſophers give only a general and ſuperficial account of the phænomena of nature from certain ſubſtantial forms, which the moſt ingenious among themſelves confeſs to be incomprehenſible, and certain real qualities, which knowing men of other perſuaſions think to be likewiſe unintelligible; both the Carteſians and the Atomiſts explicate the ſame phænomena by little bodies variouſly figured and moved. I know, that theſe two ſects of modern naturaliſts diſagree about the notion of body in general, and conſequently about the poſſibility of a true vacuum; as alſo about the origin of motion, the indefinite diviſibleneſs of matter, and ſome other points of leſs importance than theſe: but in regard that ſome of them ſeem to be rather metaphyſical than phyſiological notions, and that ſome others ſeem rather to be requiſite to the explication of the firſt origin of the univerſe, than of the phænomena of it, in the ſtate wherein we now find it; in regard of theſe, I ſay, and ſome other conſiderations, and eſpecially for this reaſon, that both parties agree in deducing all the phænomena of nature from matter and local motion; I eſteemed that, notwithſtanding theſe things, wherein the Atomiſts and the Carteſians differed, they might be thought to agree in the main, and their hypotheſes might by a perſon of a reconciling diſpoſition be looked on as, upon the matter, one philoſophy. Which becauſe it explicates things by corpuſcles, or minute bodies, may (not very unfitly) be called corpuſcular; though I ſometimes ſtyle it the Phenician philoſophy, becauſe ſome antient writers inform us, that not only before *Epicurus* and *Democritus*, but even before *Leucippus* taught in *Greece*, a Phenician naturaliſt was wont to give an account of the phænomena of nature by the motion and other affections of the minute particles of matter. Which becauſe they are obvious and very powerful in mechanical engines, I ſometimes alſo term it the mechanical hypotheſis or philoſophy.

By ſuch conſiderations then, and by this occaſion, I was invited to try, whether, without pretending to determine the abovementioned controverted points, I could, by the help of the corpuſcular philoſophy, in the ſenſe newly given of that appellation, aſſociated with chymical experiments, explicate ſome particular ſubjects more intelligibly, than they are wont to be accounted for, either by the ſchools or the chymiſts. And however ſince the vulgar philoſophy is yet ſo vulgar, that it is ſtill in great requeſt with the generality of ſcholars; and ſince the mechanical philoſophers have brought ſo few experiments to verify their aſſertions; and the chymiſts are thought to have brought ſo many on the behalf of theirs, that of thoſe, that have quitted the unſatisfactory philoſophy of the ſchools, the greater number, dazzled as it were by the experiments of Spagyriſts, have imbraced their doctrines inſtead of thoſe they deſerted: for theſe reaſons, I ſay, I hoped I might at leaſt do no unſeaſonable piece of ſervice to the corpuſcular philoſophers, by illuſtrating ſome of their notions with ſenſible experiments, and manifeſting, that the things by me treated of may be at leaſt plauſibly explicated without having recourſe to inexplicable forms, real qualities, the four peripatetick elements, or ſo much as the three chymical principles.

Being once reſolved to write ſome ſuch *ſpecimina* as I formerly judged requiſite, I ſoon bethought my ſelf of the experiment hereafter delivered concerning ſalt-petre, divers of whoſe phænomena I did alſo, as time would permit, caſt into one of the eſſays I was then engaged to write to a friend. And having diſpatched that little treatiſe, it found ſo favourable a reception among thoſe learned men, into whoſe hands it came, that I was much encouraged to illuſtrate ſome more of the doctrines of the corpuſcular philoſophy, by ſome of the experiments, wherewith my furnaces had ſupplied me; which alſo, as occaſion ſerved, I did, partly by writing ſome phyſico-chymical treatiſes, and partly by making ſuch large notes on the eſſay concerning ſalt-petre, as might plentifully contribute to the hiſtory of qualities, of which I had ſometimes thoughts. And this continued, till in the year before the laſt the publick confuſions in this (then unhappy) kingdom reducing me to quit my former deſign, together with the place, where my furnaces, my books, and my other accommodations were; I fell afterwards upon the making of pneumatical trials, whereof I lately ventured to give Viz. *A. D.* 1659.

the publick an account in a book of new experiments phyſico-mechanical about the air.

I SHOULD not trouble the reader with ſo prolix a preface to ſuch ſmall treatiſes as thoſe whereto this is prefixed, but for theſe two reaſons: The one, that I hope the foregoing narrative will make me be the more favourably judged by the philoſophers I deſire to ſerve, if ſometimes I write leſs ſkilfully of their opinions, than perhaps I ſhould have done, had I allowed my ſelf to ſearch into them: and the other, that I am earneſtly ſollicited to publiſh ſome other tracts, tending to the ſame purpoſe that theſe do; to which alſo ſhould I ever be induced, by the reception theſe may meet with, to trouble the world with them, the ſame preface, as it is now penned, may ſerve for an introduction. I had almoſt forgot to take notice, that whereas at the end of the eſſay concerning ſalt-petre I mentioned a then newly publiſhed treatiſe of the laborious *Glauber*'s, which I had not then peruſed, I found it to contain ſome obſervations concerning the hiſtory of ſalt-petre, which, if they be true, are conſiderable enough; I muſt again recommend the examination of them to the reader's curioſity, having been hindered by divers avocations from ſaving him that labour my ſelf. And whereas alſo ſome years after I was informed of another little book he had put out ſince the former, wherein he teaches us a way of purifying ſalt-petre, to make a conjunction of the ſpirituous and fixter parts of it, and then to ſuffer the mixture to evaporate and ſo cryſtallize into nitre; this would, I confeſs, have made me apprehenſive of paſſing for a plagiary with thoſe, that did not know me, but that it was eaſy for me to clear my ſelf by the teſtimony of very learned men, who had ſome years before peruſed my treatiſe, and eſpecially of one perſon, (well known by his writings) who was pleaſed to like it ſo well, as to deſire he might tranſlate it, and had accordingly long before turned it into very elegant Latin. I might perhaps venture to add, that though I could not juſtify my ſelf by ſo convincing a proof of my innocence, yet he, that ſhall take the pains to conſider, that I could not borrow of *Glauber* the various phænomena I have particularly ſet down, and much leſs the reflections on them, and ſhall compare in what differing manners, and to what differing purpoſes, we two propoſe the making of ſalt-petre out of its own ſpirit, and fixed ſalt, (he but preſcribing as a bare chymical purification of nitre, what I teach as a philoſophical redintegration of it;) he, I ſay, who ſhall compare theſe things together, will, perchance, think, that I was as likely to find this laſt named experiment as another. Which things I ſay not, as if I ſcrupled to make uſe of the induſtrious *Glauber*'s, or any other man's experiments, eſpecially, when I borrow not with them any of the doctrines I build on them; but becauſe ſince I neither did nor could take any notice of *Glauber*'s book in mine, I judged it requiſite to ſay ſomething, to prevent my being thought to have unthankfully taken one of the chief paſſages of my diſcourſe from a book, to which I was utterly a ſtranger.

THE reaſons of my thus conſenting to publiſh the following *Hiſtory of fluidity and firmneſs*, without the reſt of thoſe annotations, which I writ upon the ſame eſſay touching ſalt-petre, are partly, that theſe are my recenteſt compoſures of this nature, (having been written but the laſt year ſave one) and were ſet down, when I allowed my ſelf to be leſs unacquainted with writers addicted to the modern philoſophy; partly alſo, becauſe the conſiderableneſs of the ſubject invited me to make theſe annotations much more copious, and ſomewhat leſs unaccurate, than my notes upon almoſt any other part of the eſſay; and partly (and indeed principally) becauſe mention being ſometimes made of this hiſtory in my freſhly publiſhed phyſico-mechanical experiments, both the printer, and ſome learned gentlemen, who were pleaſed to think that book not unworthy the tranſlating, have ſollicited me to let this treatiſe be annexed to the ſeveral verſions they are about of that pneumatical piece, and to the Engliſh edition of the three fore-going diſcourſes, which the printer fears would, without the company of theſe or ſome others, make but too thin a book.

AND I thought fit to premiſe to this hiſtory the eſſay concerning ſalt-petre, not only becauſe it might appear very improper to publiſh annotations without the text it ſelf, whereunto they relate; but indeed becauſe I find, that there are ſtill many learned men, of the ſame diſpoſition with thoſe I have mentioned in the beginning of this preface; whence I am invited to divulge this eſſay by the ſame conſiderations, that at firſt induced me to write it. Eſpecially ſince I remember not, that among the new philoſophers, I have met with any one experiment, that does ſo fairly and ſenſibly accommodate ſo many of their opinions. And indeed I freely confeſs, that I ſhall think my ſelf to have done no uſeleſs ſervice to the common-wealth of learning, if I prove ſo fortunate, as by theſe, or any other writings of mine to the like purpoſe, to beget a good underſtanding betwixt the chymiſts and the mechanical philoſophers, who have hitherto been too little acquainted with one another's learning; there being to this very day a great and almoſt general miſunderſtanding betwixt the corpuſcular phyloſophers and the chimiſts; moſt of thoſe (on the one hand) looking upon the Spagyriſts as a company of mere and irrational operators, whoſe experiments may indeed be ſerviceable to apothecaries, and perhaps to phyſicians, but are uſeleſs to a philoſopher, that aims at curing no diſeaſe but that of ignorance; and moſt of the Spagyriſts (on the other hand) looking upon the Corpuſcularians (if I may ſo call them) as a ſort of empty and extravagant ſpeculators, who pretend to explicate the great book of nature, without having ſo much as looked upon the chiefeſt and the difficulteſt part of it; namely, the phænomena, that their art has added to the former edition of this vaſt and obſcure volume. But that ſome of the principal of the hermetick opinions may be more handſomely accommodated by the notions of the Phœnician hypotheſes, than by the com-

mon philoſophy of elements and ſubſtantial forms, (which yet their writers ſo frequently allude to and otherwiſe employ) may appear from hence, that whereas the ſchools generally declare the tranſmutation of one ſpecies into another, and particularly that of baſer metals into gold, to be againſt nature, and phyſically impoſſible; the corpuſcular doctrine rejecting the ſubſtantial forms of the ſchools, and making bodies to differ but in the magnitude, figure, motion or reſt, and ſituation of their component particles, which may be always infinitely varied, ſeems much more favourable to the chymical doctrine of the poſſibility of working wonderful changes, and even tranſmutations in mixt bodies. And on the other ſide, there are ſcarce any experiments, that may better accommodate the Phenician principle, than thoſe, that may be borrowed from the laboratories of chymiſts. For firſt, chymiſtry enabling us to depurate bodies, and in ſome meaſure to analyze them, and take aſunder their heterogeneous parts, in many chymical experiments we may better than in others know what manner of bodies we employ, art having made them more ſimple or uncompounded, than nature alone is wont to preſent them us. And next, many chymical operations being performed in cloſe, and yet in tranſparent veſſels, we may better know what concurs to the effects produced, becauſe adventitious bodies (or at eaſt all groſſer ones) are kept from intruding upon thoſe, whoſe operations we have a mind to conſider. And laſtly, the bodies employed by the chymiſts being for the moſt part active ones, the progreſs of nature in an experiment, and the ſeries of ſucceſſive alterations, through which the matter paſſes from firſt to laſt, is wont to be made more nimbly, and conſequently becomes the more eaſy to be taken notice of and comprehended. So that all this conſidered, I hope it may conduce to the advancement of natural philoſophy, if, as I ſaid, I be ſo happy, as, by any endeavours of mine, to poſſeſs both chymiſts and corpuſcularians of the advantages, that may redound to each party by the confederacy I am mediating between them, and excite them both to inquire more into one another's philoſophy, by manifeſting, that as many chymical experiments may be happily explicated by corpuſcularian notions, ſo many of the corpuſcularian notions may be commodiouſly either illuſtrated, or confirmed by chymical experiments.

A

PHYSICO-CHYMICAL ESSAY,

Containing an EXPERIMENT, with ſome Conſiderations touching the differing parts and redintegration of SALT-PETRE.

SECTION I.

SALT-PETRE, *Pyrophilus*, though in that form, wherein it is ſold in ſhops, it be no very obvious concrete; yet either in its rudiments, or under ſeveral diſguiſes, it is to be found in ſo great a number of compound bodies, vegetable, animal, and even mineral, that it ſeems to us to be not only one of the moſt catholick of ſalts, but ſo conſiderable an ingredient of many ſublunary concretes, that we may juſtly ſuppoſe it may well deſerve our ſerious inquiries, ſince the knowledge of it may be very conducive to the diſcovery of the nature of ſeveral other bodies, and to the improvement of divers parts of natural philoſophy.

SECT. II.

BUT not having at preſent much leiſure allowed me by ſeveral avocations, to make accurate inquiries into the nature of ſalt-petre in general; and, which is more conſiderable, being not yet furniſhed with a competent number of experiments requiſite to ſuch a purpoſe; I muſt content my ſelf for this time to tender you ſome aſſiſtance, towards the diſcovery of how differing ſubſtances may be obtained from nitre, and compound it again, by preſenting you ſome reflections on an experiment, which my deſire to haſten to another ſubject obliges me to ſet down nakedly, as I firſt tried it, by way of narrative.

SECT. III.

WE took then common nitre (as we bought it at the druggiſt's) and having by the uſual way of ſolution, filtration, and coagulation, reduced it into cryſtals, we put four ounces of this purified nitre into a ſtrong new crucible, * in which (the veſſel being firſt well nealed to

* If it be here demanded, Why the experiment was not made with a greater quantity of ſalt-petre? we may anſwer, that the mentioned quantity was moſt proportionate to the beſt crucible we then had. And if it be further asked, Whether it were not the better way of obtaining the ſeveral ſubſtances ſeparable from nitre, to diſtil it in cloſe veſſels without addition of any foreign body? we ſhall reply only by repreſenting, that the propoſed way is not ſo practicable as one would imagine: for not acquieſcing in the common practice of chymiſts, who are wont to mingle with the ſalt-petre they diſtil three or four times its weight of brick, earth, or ſome other additament, which

to prevent cracking, and covered to prevent the falling in of any thing, that might unſeaſonably kindle the petre) we melted it into a limpid liquor, and whilſt it was in fuſion, caſt into it a ſmall live coal, which preſently kindled it, and made it boil and hiſs, and flaſh for a pretty while. After which, we caſt in another glowing coal, which made it fulminate afreſh; and after that we caſt in a third and a fourth, and ſo continued the operation, till the nitre would neither fulminate nor be kindled any more. After which we continued to keep it in a ſtrong fire for above a quarter of an hour, that if any volatile part ſhould yet remain, it might be forced off.

SECT. IV.

THEN taking out the crucible, and breaking it whilſt it was hot, we took out, as carefully as we could, the remaining fixed nitre, before it had imbibed much of the moiſture of the air; and dividing it into two equal parts, we diſſolved one of thoſe portions in as much fair water, as would juſt ſuffice for the ſolution of it, and then dropped on it ſpirit of ſalt-petre, till the ebullition occaſioned by the mutual action of thoſe contrary liquors did perfectly ceaſe; and forthwith filtrating this mixure, we expoſed it in a new open phial to the air in a window; and returning to the other portion of fixed nitre, which we had ſet apart and not diſſolved, we dropped on that likewiſe of the ſame ſpirit, till the hiſſing and ebullition were altogether ceaſed, and then we expoſed this mixture alſo in an open glaſs-jar to the air in the ſame window with the former.

SECT. V.

THE event of theſe trials was, that the mixture, wherein fair water was employed, did in a few hours faſten to the lower part of the ſides of the glaſs, wherein it was put, ſome ſaline particles, which ſeemed by their form (and partly too by their ſhooting about the lower parts of the veſſel) to be ſalt-petre; amongſt whoſe little cryſtals nevertheleſs there appeared to ſwim very little grains (much ſmaller than muſtard-ſeeds) of ſome other kind of ſalt, environed with a downy matter, not unlike that, which is oftentimes to be obſerved in roſe-water, and ſeveral other diſtilled waters, when they begin to decay. The cryſtals were the next day taken out, being by that time grown ſomewhat greater, and more numerous; and diſcloſed themſelves, upon trial, to be indeed nitrous, as well by their manner of burning, as their ſhape. Concerning the latter of which, ſince learned modern writers have miſ-repreſented it, ſome making nitre to be cylindrical, and others of a figure leſs approaching to the true one; I think my ſelf obliged in this place to obſerve to you by the way, that having purpoſely conſidered ſome large cryſtals of refined and unanalyzed nitre, the figure being in ſuch beſt diſcerned, they appeared to have each of them ſix flat ſides (not always of equal breadth in reſpect of one another) whereof any two that were oppoſite were commonly parallel. But to return to our augmented cryſtals of nitre; what the other matter, that adhered to them, was, there was ſo very little of it, that we could not well diſcern, though we then ſuſpected it to proceed from the want of a juſt or exact proportion betwixt the volatile and fixed parts of the nitre, that were to be reunited.

SECT. VI.

THE remaining liquor being poured into an open glaſs-jar, and left in the ſame window, continued five or ſix days without manifeſting any conſiderable alteration; but at the end of that time there began to appear in it very fine cryſtalline ſtriæ of petre, which grew more and more numerous during a fortnight longer: at which time, being wearied with attending the ſo ſlow conſumption of the liquor, we poured it from the cryſtals, and ſet it in a digeſting furnace to evaporate more nimbly.

SECT. VII.

THE other mixture, wherein no water was employed, did preſently, for a great part of it, ſubſide in the form of ſalt; over which there ſwam a little liquor, which alſo ſeemed to keep the ſubſiding particles of ſalt from congealing into one coherent maſs, or ſo much as greater lumps: and a part of this drenched ſalt being taken out, and permitted to dry in the air, did not appear very regularly figured, but yet ſeemed here and there to recede very little from the ſhape of ſalt-petre; and being caſt on a quick coal, it burned partly after a manner not peculiar (that we have obſerved) to any diſtinct kind of ſalt; and yet it partly ſeemed to imitate the flaſhing way of deflagration proper to nitre. The remaining part of this ſalt, together with the liquor ſwimming upon it, we kept for about a month in the open air, without diſcerning any obſervable change in the liquor, till towards the latter end of that time, and then we found it partly coagulated into ſmall ſaline maſſes, whoſe figure we were not able to diſcern. And therefore diſſolving the whole mixture in a little fair water, and filtrating it, we found (after evaporation in a digeſting-furnace) about one half of the ſalt ſhot into fine ſmall icicles of the ſhape of cryſtals of petre, but ſomewhat differing from them in taſte upon their firſt being put upon the tongue; but upon a live-coal they burned not unlike petre. And the remaining half of this diſſolution, being ſomewhat haſtily preſſed to exhale, let fall its ſalt in a figure, which we could not reduce either to that of ſalt-petre, or of any other determinate kind of ſalt.

FOR

which (eſpecially in ſo great a proportion) may much alter the nature of the fixed ſalt remaining behind with it; we have had the curioſity to try more than once, whether we could diſtil ſalt-petre *per ſe* in glaſs-retorts, and found, that though to avoid giving too ſtrong a fire, we once (at leaſt) placed the retort only in a pan-full of ſand; yet when the heat was grown ſtrong enough to melt the ſalt, it cracked the retort, and did partly run out at the crack: only we obtained ſome ſmall quantity of a liquor, which by its ſourneſs and operation taught us what we might have expected of the reſt of the volatile part of the nitre, in caſe the veſſel would have held till it had paſſed over into the receiver.

FOR the clear comprehending of this experiment, you may be pleaſed, *Pyrophilus*, to take notice,

SECT. VIII.

1. THAT a new coal is not to be caſt on the nitre, till the detonation occaſioned by the former be either quite or almoſt altogether ended; unleſs it chance, that the puffing matter do blow the coal too ſoon out of the crucible, (which often enough happens towards the end of the operation:) which ſeems to happen chiefly, becauſe the firſtpart of the nitre growing to be predominant, the inflammable and halituous particles cannot break through the matter, now grown more ſtiff, but by ſuch impetuous eruptions, as make them oftentimes toſs back the coals as ſoon as ever they are caſt into the crucible: and in this way of proceeding we have been forced to ſpend much more time, than the opinion of the ready deflagrability (if I may ſo ſpeak) of ſalt-petre did beforehand permit us to imagine.

SECT. IX.

2. THAT we diſcerned by our ſcales, that the weight of the ſpirit of nitre requiſite to be dropped on, till all the ebullition made betwixt that liquor and the ſolution of fixed nitre were ceaſed, did not amount to ſo great a weight, as the ſalt-petre loſt in its detonation, and yet fell not much ſhort of it.

SECT. X.

3. THAT the fixed nitre this way made differed but very little from vulgar ſalt of tartar in its lixiviate taſte, in its aptneſs to attract the air, or to relent by the moiſture of it, and in its other more obvious qualities; only whereas ſalt of tartar is wont to be white (which nevertheleſs being fluxed has been by others, as us, obſerved to become of a kind of ſky-colour) this fixed nitre was of a deep colour betwixt blue and green: which colour, upon the affuſion of the ſpirit of nitre, vaniſhed; whereas otherwiſe (to obſerve that to you upon the by) ſome ſort of calcined nitre will ſo obſtinately retain that colour, that I keep by me a bluiſh-green liquor made of fixed-petre, I know not how oftentimes ſucceſſively reſolved *per deliquium* and coagulated again, till it would no longer be reduced to a dry ſalt, but to an unctuous body eaſily flowing in heat like wax: my deſign in which trial it were here ſomewhat improper to inſiſt on *.

SECT. XI.

AND becauſe, *Pyrophilus*, it may be ſuſpected, that the ſalt-petre mentioned to have been produced by the re-union of the volatile and fixed part of that concrete, may have been only ſome aſſociated particles of ſalt-petre, that by lurking undiſcernedly in the fixed nitre had eſcaped the analizing violence of the fire, and by the affuſion of fair water were ſet at liberty to aſſemble together, and thereby diſcloſe themſelves in their true ſhape:

To remove this ſcruple, and to let you ſee that much of the enſuing diſcourſe will not need your ſuppoſing, that the experiment of the redintegration of petre was accurately made, and did accordingly ſucceed; I muſt here annex, that though by divers other chymical experiments, which I have had occaſion to make with ſalt-petre, I ſometimes diſcovered, that now and then ſome undiſcerned particles of the ſalt-petre may poſſibly eſcape our diligence when we make fixed nitre; yet thoſe particles are too few to amount to ſuch cryſtals of petre, as the affuſion of the acid ſpirit upon the lixiviate ſalt are capable of affording. And that we have, to ſatisfy our ſelves farther in this particular, purpoſely ſatiated, according to the former manner, a ſolution of common pot-aſhes, bought of them, that are wont to ſell it in ſhops, (who are not ſo fooliſhly knaviſh, as to adulterate them with ſalt-petre, which is much dearer than pot-aſhes) and filtrating the ſolution from its copious *fæces*, found after evaporation, in the remaining liquor, within about two or three days, and ſometimes much ſooner, pretty ſtore of cryſtalline ſalt in a nitrous figure, which though at firſt it taſted ſomewhat corroſively, (perhaps becauſe the proportion betwixt the nitrous ſpirit and the pot-aſhes was not duly obſerved) yet after it had a while remained upon the tongue, the taſte of it much emulated that of ſalt-petre; and part

* That our friends might not be obliged to wait ſo long for the redintegration of nitre, but might ſee the experiment made in as little time as is poſſible, we deviſed a more expeditious way of uniting the divorced parts of our ſalt, and it was only by ſuffering ſuch fixed nitre, as is mentioned by our author, to run *per deliquium* into a liquor, which being ſeparated from its *fæces* by filtration through cap-paper was very clear and limpid: for, when we had a mind to ſhew the experiment, we did only upon this liquor drop ſome ſpirit of nitre, and that, after ſuch a noiſe, ſparkling and efferveſcence, as our author ſpeaks of, (all which haſtily vaniſhed) did immediately aſſociate it ſelf with a competent proportion of the fixed ſalt ſwimming in the ſolution, and therewith fall down in little icicles of a nitrous ſhape and nature; and when we pleaſed to continue the affuſion of the acid ſpirit, this emergency of ſalt-petre would be obſervable from time to time, till either all, or almoſt all the fixed ſalt had united it ſelf with the other. And theſe little icicles being dried in lumps, did as well upon the tongue and upon a quick coal, as they had done to the eye, diſcloſe themſelves to be ſo truly nitrous, that our friends were not wont without ſome wonder, as well as much pleaſure, to behold ſalt-petre thus ſuddenly generated in leſs than a minute of an hour. Theſe ſmall icicles being in ſufficient plenty diſſolved in fair water, we did for trial's ſake reduce by congelation to fairer cryſtals.

But though this be the perfecteſt and readieſt way of re-producing nitre, yet becauſe it often requires, eſpecially in dry weather, a long time to reduce fixed nitre *per deliquium* into a liquor, we have ſometimes ſubſtituted the following way. We diſſolved in fair water as much fixed nitre as we could, and filtrating the ſolution through cap-paper, we ſatiated it with ſpirit of nitre, after the manner above deſcribed; and then ſetting it to evaporate very ſlowly, and afterwards ſuffering it to cool, we obtained, within ſome hours after the firſt mixture of the liquors, ſtore of fine little cryſtals of petre, which ſhot in the liquor; the remaining part of which being evaporated afforded more of them. And though the evaporation and cryſtallization coſt us divers hours, yet it ſeemed, that the ſalt-petre was produced preſently upon the ceaſing of the conflict betwixt the two liquors. For the mixture, before evaporation, taſted very like a ſolution of common nitre, and the little drops, that upon the efferveſcence skipped out of the glaſs, and fell back upon the ſides of it, did there many of them preſently coagulate into little grains of nitrous ſalt.

part of it being caſt upon a live coal, did by its blue and halituous flame diſcover it ſelf to be of the nature of that ſalt. To which we may add, that we likewiſe tried the experiment with aqua fortis and ſalt of tartar, and thereby produced ſalt-petre, though but in ſmall quantity, and a long time. And thoſe two additional experiments I the rather mention, becauſe many of the enſuing reflections may be juſtified by them, although the main experiment made on ſalt-petre alone ſhould in divers particulars be ſuppoſed (for we have uſed our endeavours that it may not be found;) to have been miſtaken.

SECT. XII.

THE reflections, which may be made on this experiment, are more than I have either the ſkill or leiſure to proſecute; and therefore I ſhall content myſelf to preſent you very ſuccinctly with a few of thoſe, that do the moſt readily occur to my preſent thoughts.

AND firſt, this experiment ſeems to afford us an inſtance, by which we may diſcern, that motion, figure, and diſpoſition of parts, and ſuch like primary and mechanical affections (if I may ſo call them) of matter, may ſuffice to produce thoſe more ſecondary affections of bodies, which are wont to be called ſenſible qualities.

SECT. XIII.

AND to begin with the tangible qualities, as heat and cold; it is commonly held, that ſalt-petre is in operation a cold body, if not one of the coldeſt in the world; and accordingly phyſicians and chymiſts are wont to give it in fevers, to allay the inward exæſtuations of the blood and humours: and that profound naturaliſt the Lord *Verulam* highly commends a little of it, and did for many years himſelf make uſe of it, to condenſe the ſpirits. But wherever it be in inward operation, certainly to the outward ſenſe it appears very cold: and yet the parts of this ſo cold body (its ſpirit and alkali, by the latter of which chymiſts are wont to mean any fixed ſalt produced by burning) put together, do immediately agitate each other with great vehemency; and did in our experiment produce ſuch an heat, that I could ſcarcely endure to hold in my hand the phial, wherein much leſs than an ounce of each was mixed, though but leiſurely and almoſt by drops; as if heat were nothing but a various and nimble motion of the minute particles of bodies. For in our experiment, as long as that confuſed agitation laſted, ſo long the heat endured, and with that agitation it increaſed and abated; and at length, when the motion ceaſed, the heat alſo vaniſhed.

SECT. XIV.

UPON the mixture of the two fore-mentioned liquors, there was alſo produced a very audible ſound, not unlike the hiſſing produced by the quenching of a live coal in water; and this hiſſing was, as that other is wont to be, accompanied with an efferveſcence and boiling up of the liquor, with ſtore of bubbles, till it was ready to run over the veſſel. This ſound ſeemed to proceed from the nimble and ſmart percuſſions of the ambient air, made by the ſwift and irregular motions of the particles of the liquors: and ſuch a kind of ſound, but much louder, was produced by the impetuous eruptions of the halituous flames of the ſalt-petre upon the caſting of a live coal upon it. What intereſt ſuch a ſmartneſs in ſtriking the air hath in the production of ſound, may in ſome meaſure appear by the motion of a bullet, and that of a ſwitch or other wand, which produce no ſound, if they do but ſlowly paſs through the air; whereas if the one do ſmartly ſtrike the air, and the other be ſhot out of a gun, the celerity of their percuſſions on the air puts it into an undulating motion, which reaching the ear, produces an audible noiſe, even at a good diſtance from the body, whoſe ſwift paſſage cauſes thoſe nimble vibrations in the air, as we may elſewhere have occaſion to declare. And that in the ſound obſervable in our experiment, the contiguous air receives many ſtrokes from the particles of the liquor, ſeems probable, by the ſudden and eager tumultuation of the parts of the liquors; and by this, that the noiſe increaſed and decayed proportionably to the ebullition of the liquors, and ceaſed altogether as ſoon as the ſaline particles floating in them had by their conflict tired themſelves in to quietneſs. And it is to be obſerved, that the noiſe ended long before the heat. To the latter of which ſuch an inteſtine tumult of the parts of many bodies is ſufficient, as is yet uncapable to produce a ſound. As we ſee in amber or good hard wax heated by rubbing; and in many liquors, which retain a conſiderable degree of heat a good while after the expiration of the noiſe they made in boiling.

SECT. XV.

WE mentioned alſo, that our fixed petre was of a bluiſh green colour, which upon the affuſion of the acid ſpirit ſuddenly vaniſhed; that diſpoſition of parts, whereby the light reflected to the eye, was ſo modified as to produce that colour, being now altered. And the like change we have ſometimes obſerved to be producible in fixed nitre, by the bare leaving it a while in the moiſt air. To which I muſt add, that in ſome ſuch kind of experiments I have obſerved the copious fumes, ariſing from the mixture, to make the unfilled part of the glaſs look of a reddiſh colour; which is not moreodd than that, which we have lately had opportunity to obſerve in ſoot, which though it be ſo black itſelf, and reſult from the coalition of dark exhalations, yet preſſed with a ſtrong fire, has filled our receivers with fumes white enough to make them look, as if they were repleniſhed with milk. And we have ſometimes alſo taken great pleaſure to behold the variety of colours, which may be now and then diſcerned in the ſublimate, made by gradually ſubliming in an urinal a mixture of equal parts of only white ſal-armoniac and black antimony. But to wander no longer far from our preſent experiment, give me leave to inform you, that a while ſince attempting

to make ſalt of tartar, I diſſolved in a little fair water an ingredient of ſalt-petre; by the addition of good aqua fortis, the union of theſe two liquors produced a deep green colour, which not only was diffuſed quite through the mixture, but alſo appeared to reſide peculiarly in certain particles of it. For having for trial-ſake filtred it through cap-paper, there remained in the filtre a powder of a very deep and lovely colour, but in ſo little quantity, that we could not attempt any experiment upon it to make it confeſs its nature. But this circumſtance is not to be omitted, that the ſalt of tartar, that was then employed, was extraordinay pure, having been by a peculiar art (elſewhere to be taught you) brought, without any addition, into fair-figured cryſtals almoſt like lumps of white ſugar-candy. To which I muſt add, that the ſame aqua fortis, with a ſolution of other pure ſalt of tartar, did likewiſe produce a colour much reſembling the former, but much fainter. And it is farther to be taken notice of on this ſubject, partly, that nitre it ſelf, although it ſeem to have nothing of kin to redneſs, doth in diſtillation yield blood-red fumes (fondly called by ſome chymiſts the blood of the ſalamander) which fall again into a liquor that has nothing of red in it; and partly, that the fixed nitre, that did before appear opacous, by a new diſpoſition of its parts conjoined with thoſe of its re-imbibed ſpirit, becomes again ſomewhat diaphanous and cryſtalline, as it was at firſt.

SECT. XVI.

UPON the mixture of theſe two liquors there alſo obtrudes it ſelf upon the ſenſe a very ſtrong and offenſive ſmell, proceeding from the ſpirit of petre; which perhaps occaſioned ſome chymiſts to call a menſtruum (wherein that nitrous ſpirit and ſmell is predominant) the Stygian water. But though the nitrous ſpirit have a very ſtrong and unwelcome odour of it ſelf, yet is it made much more offenſive by being poured on its own fixed ſalt; for upon their conflict, the matter, being vehemently agitated, doth more copiouſly emit ſuch ſtinking exhalations than before, and ſendeth forth fumes manifeſtly diſcernible as well to the eye as noſtrils. The odour of the fixed nitre is very languid; but that, which it diſcovers, being diſſolved in a little hot water, is altogether differing from the ſtink of the other, being of kin to that of other alkalizate ſalts. And yet the ſalt-petre, from which ſuch differingly-ſcented bodies ſpring, and which may again emerge from the coalition of them, has not been obſerved, as I remember, to have any ſmell at all.

SECT. XVII.

THE taſtes of theſe two bodies are as differing as any of their other qualities: for the ſpirit is exceedingly acid, and may be called a ſtrong and ſour *Acetum Minerale*; whereas the fixt nitre has as ſtrong a taſte of ſalt of tartar as the ſpirit has of diſtilled vinegar: and yet theſe two bodies, whoſe ſapours are ſo pungent, and ſo differing, do both ſpring from and unite into ſalt-petre, which betrays upon the tongue no heat nor corroſiveneſs at all, but coldneſs mixt with a ſomewhat languid reliſh retaining to bitterneſs. And though we muſt not conceal from you, that in our trial the redintegrated ſalt-petre had upon its firſt impreſſion upon the tongue a taſte more ſharp and perforating (if I may ſo ſpeak) than ordinary nitre; yet that pungency may not improbably be ſuppoſed to have proceeded from ſome acid particles of the ſpirit, that were not yet duly incorporated with, but only looſely adherent to, the more perfectly nitrous parts, which afterwards diſcovered it ſelf upon the tongue. And however, the difference betwixt the taſte of this new ſalt, and thoſe of the acid and alkalizate ſalts whereof it conſiſted, and (unqueſtionably) the taſte of theſe compared with that of the crude petre, which was diſſipated into them, were ſufficient to warrant this reflection.

SECT. XVIII.

OF the other obſervables preſented us by our experiment, we muſt, *Pyrophilus*, content our ſelves to mention but a few; our haſte being ſuch, that it will not permit us either to enumerate them all, or to inſiſt long on any of them.

SECT. XIX.

SECONDLY then, the propoſed experiment ſeems to make it ſomewhat queſtionable, whether or no inflammability doth ſtrictly in all mixt bodies require a diſtinct ſulphureous ingredient; and whether or no in ſome concretes it may not reſult from ſuch a contrivance of parts, as that thereby the particles of the concrete are diſpoſed to be ſet a moving by the adventitious, whether fiery or calorifick, corpuſcles of another body, in ſuch numbers, and with ſuch celerity, as may put them into that ſcheme of matter, which we call flame. How violent an heat may be produced upon ſuch an account as this, may in ſome meaſure appear by an experiment, wherein our preſent theme ſalt-petre is the main agent. For if into a phial filled with good ſpirit of nitre you caſt a piece of iron, you may perceive, that the liquor, whoſe parts moved placidly and uniformly before, manifeſted no heat to the touch, meeting with pores and particles in the iron capable of very much altering the motion of its parts, (and perhaps alſo that of ſome very ſubtile intercurrent matter,) thoſe active parts do preſently begin to penetrate, ſever, and ſcatter abroad the particles of the iron, (almoſt as gunpowder doth the pieces of breaking granadoes) with ſuch rapidity, and in ſuch plenty and throngs, that being themſelves alſo put into a very ſwift and irregular motion (whence ſoever it proceeds) there is hereby produced a heat capable (if the quantity of the liquor and metal be great enough) to burn his hand, that holds the veſſel, and perhaps break the veſſel (if it be not very open) all to pieces: whereas by caſting into the ſame ſpirit of nitre little lumps of camphire, whoſe particles were indiſpoſed to occaſion the like diſturbance and agitation in the nitrous ſpirit, we obſerved the

agitation made of the particles of the white gum to change it only into a yellowiſh and fluid ſeeming oil.

SECT. XX.

BUT not to wander any further, our own experiment informs us, that ſalt-petre (which not only is inflammable, but burns very fiercely and violently) may be produced by the coalition of two bodies, which are neither of them inflammable; the one being a fixed ſalt, that to become ſuch has already ſuffered the loſs of all that the fire could deprive it of, and the other being a ſpirit abounding with acid particles, which kind of ſalts have been obſerved to be more apt to quench than foment fire.

SECT. XXI.

AND becauſe we may elſewhere, God aſſiſting, treat more particularly of the inflammableneſs of bodies, we will now add but a few lines concerning that of nitre, that this circumſtance of it might not eſcape our obſervation; namely, that upon caſting ſalt-petre on a glowing coal, or upon the caſting of a glowing coal into melted ſalt-petre, the nitre will immediately take fire, and flaſh out into bluiſh and halituous flames; whereas if the ſame nitre be placed in a crucible, though that crucible be by degrees made glowing hot, and do immediately with its concave ſurface in innumerable places touch the particles of nitre, yet the ſtrange ſalt will be thereby melted, but not kindled. The reaſon of which phænomenon I muſt not now (but may on another occaſion) ſpend time to inquire after.

SECT. XXII.

It may alſo, *Pyrophilus*, deſerve the inquiry, whence it proceeds, that whereas the body of ſalt-petre, when committed to diſtillation, is oftentimes very well dried, and conſiſts of ſaline parts, which are generally accounted to be of a very dry nature, yet the ſpirits of petre forced by the fire into the receiver ſhould not, like ſal-armoniac, and ſome other bodies diſtilled with the like heat and veſſels, adhere in the form of ſublimate to the receiver, but fall into a liquor, which does not, for aught we have ſeen or heard of, either totally or in part coagulate again in the cold, as we have ſeen ſpirit of urine and other volatile liquors (afforded by animal ſubſtances) often do; and as we have obſerved, though rarely, even in the corroſive liquor, that is wont to be called butter of antimony. And the like inquiry may be made concerning the liquidneſs of the diſtilled ſpirits of decrepitated ſalt, calcined vitriol, and divers other bodies, which ſeem to have been deſtitute of moiſture, when committed to diſtillation.

SECT. XXIII.

BUT this not being preciſely a phænomenon of our experiment, we ſhall not here proſecute it, (though perhaps we elſewhere may) but rather obſerve to you, *Pyrophilus*, that whereas good ſpirit of nitre being left in an open veſſel, is wont to ſmoak and waſte it ſelf in an exhalation ſenſible, eſpecially if it be excited by a little heat, not only in the noſe but to the eye; this fugitive ſpirit, when it is once re-united to its own fixed ſalt, emits no ſuch ſteam, though kept a good while near a conſiderable fire: which inſtance may ſomewhat aſſiſt us to make out, that the moſt fugitive parts of concretes may in ſpight of their natural mobility be detained in bodies by their union and texture with the more ſluggiſh parts of them, among which thoſe lighter and more active ingredients may be ſo entangled, as to be reſtrained from avolation.

SECT. XXIV.

ANOTHER thing worth conſidering in our experiment is this, that upon the dropping of the acid ſpirit into the alkalizate liquor, if you place the open-mouthed glaſs, wherein the experiment is performed, betwixt the light and your eye, you may plainly diſcern, that the ſaline particles of theſe liquors toſs one another (or are toſſed by ſome briſk inviſible ſubſtance) to the height of divers fingers breadth up into the air, whence moſt of them fall back into the veſſel like a thick ſhower of little drops of rain. And it were worth inquiring, whence this ſparkling of the parts of theſe mixed liquors ariſes; and whether the ſaline corpuſcles may be conceived rapidly to move differing ways, and ſo, thwarting each other in their courſes, and rudely joſtling at their occurſions, ſome of them are forced to bound or fly upwards, (almoſt like ivory balls meeting each other on a billiard-table,) And to aſſiſt you in this inquiry, give me leave to inform you, that the particles thus thrown into the air appear to be moſt of them ſaline by this obſervation; that ſoon after the fall of the fore-mentioned ſhowers, you ſhall find the ſides of the glaſs, wherein the affuſion of the nitrous ſpirit has been made, all embroidered with little grains of ſalt, left there by thoſe wandering drops, that fell beſides the liquor.

SECT. XXV.

AND let me farther obſerve to you, that there ſeems to be a very nimble agitation in the particles of the ſpirit of nitre, by this, that upon the pouring of aqua fortis (whoſe active part is little elſe than ſpirit of nitre) upon a ſolution of ſalt of tartar in fair water, in which divers ſmall lumps of the ſalt remained yet undiſſolved, we have obſerved the acid ſpirit to ſever the particles of the ſalt with ſuch impetuoſity, that the numberleſs little bubbles produced upon their conflict, and haſtily aſcending in ſwarms from ſome of the little lumps, made them emulate ſo many little, but rapidly riſing, ſprings. And to make it yet appear more probable, that there may be ſuch croſſing motions in the parts of theſe liquors, we obſerved, that after the two contrary ſalts had by their mutual conflict tired each other, (or rather had been upon their occurſions faſtened to one another) there would follow no farther ebullition or ſkipping up and down of little drops of the liquors, upon the putting in of more ſpirit of nitre, unleſs there were added likewiſe more of the alkalizate liquor.

SECT.

SECT. XXVI.

AND, before we paſs on from this reflection, it may not be uſeleſs to take notice of the difference, that there may be betwixt thoſe active parts of a body, which are of differing natures, when they are as it were ſheathed up, or wedged in amongſt others in the texture of a concrete; and the ſame particles, (when extricated from theſe impediments) they are ſet at liberty to flock together, and by the exerciſe of their nimble motions diſplay their proper, but formerly clogged activity, or acquire a diſpoſition to be briſkly agitated by ſome fine interfluent matter. For though in the intire body of ſalt-petre the ingredients it conſiſts of, or the differing ſubſtances, into which the fire diſſipates it, do ſo mutually implicate and hinder each other, that the concrete, whilſt ſuch, acts but very languidly; yet when the parts come to be diſlocated, and the halituous and alkalizate particles are enabled or made to diſband from the concrete, and aſſociate themſelves with thoſe of their own nature, we ſee with how great an activity both the acid ſpirit and the fixed ſalt are endowed.

SECT. XXVII.

AND we may yet farther obſerve, that it is not barely an indefinite nimbleneſs of motion, and activity of the particles of ſaline liquors, that enables them to perform each of their particular effects: for to the production of ſome of theſe there ſeems requiſite, beſides perhaps a modification of their motion, a determinate figure of the corpuſcles, anſwerable to that of the pores of the body by them to be diſſolved; as ſpirit of nitre corrodes ſilver, but not gold; which nevertheleſs its particles aſſociated with thoſe of ſal-armoniac, and thereby acquiring a new figure, and perhaps a differing motion, will readily diſſolve: and the liquor of fixed nitre will, for the ſame reaſon, diſſolve ſuch ſulphureous and unctuous bodies as the acid ſpirit will not corrode: nay, and I have carefully obſerved, that there may be liquors, that will not diſſolve ſome bodies, unleſs the motion or activity of their particles be allayed or modified by the mixture of fair water, or ſuch unactive vehicles.

SECT. XXVIII.

ANOTHER particular, which in our experiment we may take notice of, is, the unwarineſs of thoſe vulgar chymiſts, who preſume confidently (and indiſcriminately enough) to aſcribe to each of the heterogeneous ingredients, or (in their language) principles of a concrete analyſis by the fire, the virtues and properties (perhaps too in an exalted degree) of the entire body. But though this be an error of very ill conſequence in reference to divers chymical preparations of medicines; yet having elſewhere diſcourſed purpoſely of it, we ſhall here content our ſelves to alledge againſt it the inſtances afforded us by the experiment under conſideration: for in that we may obſerve, that when ſalt-petre is diſtilled, the volatile liquor and fixed ſalt, into which it is reduced by the fire, are endowed with properties exceeding different both from each other, and from thoſe of the undiſſipated concrete. For the ſpirit of nitre is (as we formerly have obſerved) a kind of *Acetum Minerale*, and poſſeſſes the common qualities to be met with in acid ſpirits as ſuch; whereas the fixed nitre is of an alkalizate nature, and participates the qualities belonging generally to lixiviate ſalts; and ſalt-petre it ſelf is a peculiar ſort of ſalt, diſcriminated by diſtinct properties both from thoſe ſalts, that are eminently acid, as allum, vitriol, ſal-gemmæ, *&c.* and from thoſe, that are properly alkalizate, as ſalt of tartar and pot-aſhes; and accordingly, we may eaſily obſerve a vaſt diſparity in the effects and operations of theſe three bodies. For ſeveral, if not all of thoſe mineral ones, which aqua fortis will by corroding diſſolve, the ſolution of fixed nitre will precipitate; and divers, if not all of thoſe ſulphureous and unctuous bodies, which the ſolution of fixed nitre will diſſolve, the acid ſpirit of petre will precipitate. And we have in a trice re-diſſolved with the ſpirit a ſolution of ſublimate precipitated with the other liquor: thus, if into a ſcarlet tincture made by an infuſion of Braſil in fair water, we pour a little ſpirit of nitre, the ſhaken liquor will in a moment change its redneſs for a kind of yellow, which by pouring on it a little of the ſolution of fixed nitre, may be again graduated into a ſomewhat ſanguine colour, ſometimes paler, and ſometimes perhaps deeper than the firſt; whereas a ſolution of ſalt-petre it ſelf poured on either of the former tinctures, the red or the yellow, has not been by us diſcerned to have produced any ſenſible alteration. And whereas ſalt-petre it ſelf is partly fixed, and partly volatile, the acid ingredients of it are altogether volatile, the alkalizate fixed. But having elſewhere occaſion to ſpeak to this ſubject, we ſhall now proceed to tell you, that

SECT. XXIX.

IT may paſs to another obſervable preſented us by our experiment, that it gives us occaſion to inquire, whether the air doth not contribute ſomething to the artificial production of ſalt-petre, or at leaſt to the figuration of it according to the perfecter ſhape belonging to that kind of ſalt: for we formerly obſerved, that the ſalt, which was leiſurely permitted to ſhoot of it ſelf in the liquor expoſed to the open air, did ſhoot into more fair and large cryſtalline ſtriæ, than thoſe, that were gained out of the remaining part of the ſame liquor by a more haſty evaporation, though made but in a digeſting furnace. And we have alſo obſerved, that when once we poured aqua fortis on a ſtrong ſolution of ſalt of tartar, till no further effervеſcence was diſcernable betwixt them, though the mixture by a ſomewhat quick heat afforded a ſalt, that ſeemed to be very nitrous, yet it would not be brought to ſhoot in ſo fair and conſpicuouſly figured cryſtals of petre, till it had been a good while expoſed to the open air: but whether the air it ſelf impregnated with the promiſcuous ſteams of moſt of the bodies of the terreſtrial globe, (and perhaps with ſeminal effluvia from ſome of them) do

really

really contribute any thing either to the production or figuration of ſalt-petre in our experiment, I dare not yet determine, for two chief reaſons.

SECT. XXX.

WHEREOF the firſt is, becauſe the figuration ſeems not improbably aſcribable, not ſo much to the proper efficiency of the air, as to the conveniency, which by quietneſs, and a competent vehicle to move in, was afforded to the ſaline particles, to conform themſelves (or be conformed by a concourſe of agents and circumſtances) to that figure, which is moſt natural to them. For we have obſerved already, that the fixed nitre, which was not diſſolved in water, before the affuſion of the acid ſpirit, did not ſhoot into the wonted form of cryſtals of petre, but remained a kind of nitrous powder, the acid and alkalizate ſaline particles not having a convenient vehicle to expand themſelves in; but being neceſſitated, for want of room, to make an unſeaſonable and over-haſty coalition, upon which their own weight made them ſubſide in the figures reſulting from their caſual concourſe, and therefore probably differing from thoſe, into which the ſaline corpuſcles would have been diſpoſed, had they been allowed a competency of vehicle and time.

SECT. XXXI.

THE other reaſon of my heſitancy about the uſe of the air in our experiment, is, that I inconſiderately forgot to try, whether part of that liquor, which ſhot into cryſtals in an open-mouthed glaſs expoſed to the air, would not have done the like, if it had been left quiet as long as the other was, though in a veſſel accurately ſtopped *: but whatever the air hath to do in this experiment, I dare invite you to believe, that it is ſo enriched with variety of ſteams from terreſtrial (not here to determine whether it receive not ſome alſo from celeſtial) bodies, that the inquiring into the further uſes of it, (for I mean not its known uſes in reſpiration, ſailing, pneumatical engines, *&c.*) may very well deſerve your curioſity. To encourage which, I dare at preſent only tell you, that though I cannot yet pretend to much experience in this particular, yet we have known ſuch changes (ſeemingly chymical) made in ſome ſaline concretes, by the help chiefly of the volatilizing operations of the open air, as very few, ſave thoſe, that have attentively conſidered what *Helmont*, and one or two other artiſts, have hinted on that ſubject, or have made trials of that nature themſelves, will be apt to imagine.

SECT. XXXII.

AND if upon further and exacter trial it appears, that the whole body of the ſalt-petre, after its having been ſever'd into very differing parts, by diſtillation, may be adequately re-united into ſalt-petre equiponderant to its firſt ſelf; this experiment will afford us a noble and (for aught we have hitherto met with) ſingle inſtance to make it probable, that that, which is commonly called the form of a concrete, which gives it its being and denomination, and from whence all its qualities are in the vulgar philoſophy, by I know not what inexplicable ways, ſuppoſed to flow, may be in ſome bodies but a modification of the matter they conſiſt of; whoſe parts, by being ſo and ſo diſpoſed in relation to each other, conſtitute ſuch a determinate kind of body, endowed with ſuch and ſuch properties. Whereas if the ſame parts were otherwiſe diſpoſed, they would conſtitute other bodies of very differing natures from that of the concrete, whoſe parts they formerly were, and which may again reſult or be produced after its diſſipation and ſeeming deſtruction, by the re-union of the ſame component particles, aſſociated according to their former diſpoſition.

SECT. XXXIII.

THE redintegration (or re-production) of an analyzed body, if it can be accurately and really performed, may give much light to many particulars in philoſophy, and would certainly be very welcome both to the embracers of the atomical hypotheſis, and generally to thoſe other modern naturaliſts, who aſpire to ſuch explications of nature's phænomena as may at leaſt be underſtood: all whom I wiſh, that though men cannot perhaps in all things, yet at leaſt as far as they can, they would accuſtom themſelves to ſpeak and think, as nature does really and ſenſibly appear to work; and not to acquieſce in notions and explications of things, which, ſtrictly examined, are not intelligible.

WHEREFORE I am about to attempt a reproduction in vitriol, turpentine, and ſome other concretes, in which it ſeems not unlikely to be performable: and perhaps you may ſee cauſe to think, that the experiment of ſalt-petre, even as we have already made and propoſed it, though it be not an exact and adequate redintegration, is yet not far from being a real one; the diſſipated parts of the concrete truly re-uniting into a body of the ſame nature with the former, though not altogether of the ſame bulk.

SECT. XXXIV.

AND yet I think it requiſite to repreſent to you, *Pyrophilus*, that ſalt-petre is a body, whoſe parts are not organical, and which is not ſo much as very compounded; and that therefore bodies, that conſiſt of more numerous ingredients, and much more thoſe, whoſe organical parts require a much more artificial and elaborate diſpoſition or contrivance of their component particles, cannot be ſafely judged of, by what is poſſible to be performed on a body of ſo ſimple and ſlight a contexture as is ſalt-petre: for we ſee, that even wine, though no organical body, nor ſo much as the moſt compounded

* Whether the air have any great intereſt in the figuration or in the re-production of nitre, the author hath ſince examined by particular trials; but in veſſels and by ways not to be eaſily deſcribed in few words, and therefore the further mention of them is reſerved for another diſcourſe.

of inanimate concretes, when its ſpirit is, though by the gentleſt diſtillation, drawn from it, will not, by the re-union of its conſtituent liquors, be reduced to its priſtine nature; becauſe the workmanſhip of nature in the diſpoſition of the parts was too elaborate to be imitable, or repairable by the bare and inartificial appoſition of thoſe divided parts to each other: beſides that in the diſſociating action, even of the gentleſt fire, upon a concrete, there does perhaps vaniſh, though undiſcernedly, ſome active and fugitive particles, whoſe preſence was requiſite to contain the concrete under ſuch a determinate form; as we ſee in wine degenerating into vinegar, where the change ſeems to proceed from this, that upon the avolation, or (if I may ſo ſpeak) depreſſion, of ſome ſubtile ſulphureous ſpirits, whoſe receſs or degeneration is not to be perceived by any ſenſible diminution of bulk in the liquor, the remaining parts fall into new leagues or diſpoſitions, and conſtitute an acid liquor ſomewhat fixed and corroſive, and conſequently of qualities very differing from thoſe of the wine, whoſe ſouring produced it: as we more fully declare in our experiments relating to fermentation.

SECT. XXXV.

AND certainly there is, as we formerly ſaid, ſo artificial a contrivance of particles requiſite to the conſtitution of the organical parts of living bodies, that it will be ſcarce poſſible for human art or induſtry to imitate, ſo as to equal thoſe exquiſite productions of nature. And therefore I wonder not, that the ſtory of the phœnix's reſurrection out of her own aſhes ſhould, by the beſt naturaliſts, be thought a meer fiction. And if that relation, mentioned by the inquiſitive *Kircherus* as an eye-witneſs of the re-production (if I may ſo call it) of ſhell-fiſhes near the brink of a lake in the Sicilian promontory *Peloro*, by the watering of their broken bodies with ſalt-water in the ſpring, be ſtrictly true, it ſeems much more improbable, that ſuch changes and viciſſitudes ſhould be bare redintegration of the diſſociated parts of ſuch reſtored bodies; than that, (according to what we * elſewhere teach,) they ſhould be new productions made by ſome ſeminal particles undiſcernedly lurking in ſome part of the deſtroyed body, and afterwards excited and aſſiſted by a genial and cheriſhing heat ſo to act upon the fit and obſequious matter, wherein it was harboured, as to organize and faſhion that diſpoſed matter according to the exigencies of its own nature. For that in ſome bodies the ſeminal particles may a while ſurvive the ſeeming deſtruction of life, is not altogether without example, as we elſewhere profeſſedly manifeſt. And in *Kircher*'s ſtory it is to obſerved, that the reſtored animals were but ſhell-fiſh; in whoſe ſlimy and viſcous ſubſtance the ſpirits and prolifick parts are probably both more diffuſed and kept from being eaſily diſſipable; to which I know not whether it will be worth while to ſubjoin, that in ſuch fiſhes the mechanical contrivance is but very plain, and, as it were, ſlight and obvious, in compariſon of the exquiſitely elaborated parts of more perfect animals.

Lib. 3. de Arte Magnet. Par. 5. cap. 3.

SECT. XXXVI.

THE laſt obſervable, *Pyrophilus*, that we ſhall at preſent take notice of in our experiment, ſhall be this, that it may thereby ſeem probable, that ſome chymical remedies may be too raſhly rejected by phyſicians, becauſe oil or ſpirit of vitriol, aqua regis, or other corroſive liquors, have been employed in their preparation: for it is confidently affirmed by many phyſicians, and but faintly denied by ſome chymiſts, that the corroſive menſtruums made uſe of in the preparation of remedies, can never be ſo exquiſitely waſhed off from them, but that ſome of the ſalts will adhere to the medicines, and perniciouſly diſplay their corroſive nature in the body of him, that takes them. And it is not to be denied, but that many ignorant and venturous chymiſts do unſkilfully (and therefore dangerouſly enough) imploy corroſives ſometimes without any neceſſity or real advantage to invite them to it, and ſometimes without ſufficiently freeing their medicines from the corroding ſalts, by whoſe aſſiſtance they were prepared. For it is not always the frequency of ablution, though with warm water, that will ſuffice to carry off the ſalts from ſome bodies; and therefore thoſe great artiſts *Helmont* and *Paracelſus* preſcribe ſome things to be dulcified by the abſtraction of the water of whites of eggs, (which, though it ſeemed inſipid, hath been found a great diſarmer of corroſive ſalts) and others by the frequent diſtillation of ſpirit of wine, which indeed (not to mention the balſamick parts it may leave behind) we have obſerved to have a faculty of carrying up with it the ſaline particles of ſpirit of vinegar adhering to ſome chymical remedies. But all this notwithſtanding, *Pyrophilus*, there may be ſeveral bodies (and perhaps more than are commonly taken notice of) which quite alter the nature of the acid ſalts employed to prepare them, by occaſioning thoſe ſalts to degenerate into another nature, upon the very act of corroding, or elſe by ſo aſſociating their own ſalts with one of thoſe of the diſſolving menſtruum, that from the coalition of both, there emerges a third body differing in qualities from either. As in our experiment we find, that the ſpirit of petre, which is much more ſharp and corroſive than the ſtrongeſt diſtilled vinegar, and the fixed nitre, which is cauſtick like ſalt of tartar, and may, I ſuppoſe, well ſerve for a potential cautery, (as ſurgeons ſpeak) do by their mutual action work themſelves into ſalt-petre, which is far enough from having any eminently fretting quality, and may be ſafely taken inwardly in a much greater doſe than either of its ingredients.

SECT. XXXVII.

How much corroſive ſalts may dulcify themſelves by corroding ſome bodies, you may eaſily try, by pouring diſtilled vinegar, or moderate ſpirit of vitriol, upon a competent proportion

* In ſome papers about the origin of living creatures ſuppoſed to ſpring of themſelves.

portion of corals, or crabs eyes, or pearls, (or, as I ſuppoſe, almoſt any teſtaceous body.) And for my part, though I am very ſhy of imploying corroſive liquors in the preparation of medicines; yet I have lately given a preparation of refined ſilver made with aqua fortis it ſelf, or ſpirit of nitre, not only innocently, but with ſuch ſucceſs, that a couple of experienced phyſicians themſelves, that were troubled with a ſuperfluity of ſerous humours, ſent to requeſt it of me for their own uſe.

SECT. XXXVIII.

IT were therefore worth while, in every preparation, where corroſive liquors are wont to be imployed, or may ſeem requiſite to be ſo, to conſider the diſtinct nature of the particular bodies to be wrought upon, or conſult experience, whether or no the acid menſtruum do communicate to the concrete any particles capable of retaining their fretting quality after the end of the operation; or whether or no the ſalts do not ſo ſpend and tire themſelves in the act of corroding, that being as it were ſheathed, they become unable to corrode any further; or whether or no the menſtruum do not in the body to be corroded meet with ſome ſuch ſaline particles, as may with it conſtitute a new and inoffenſive ſubſtance, as when ſpirit of vinegar, by corroding calcined lead, is turned with it into a ſalt, not of an acid, but a ſaccharine taſte, ſuch as invited chymiſts to give it the name of ſugar of *Saturn*. In the former of theſe caſes the medicine may be dangerous, unleſs it be after the ſolution or corroſion ended exquiſitely dulcified from all remainder of the corroſive ſalts. But in the two latter caſes the remedies may, in ſpite of the corroſiveneſs of the menſtruums employed about them, be ſafe and innocent enough; for it matters not much, how ſharp and fretting the ſever'd ingredients of a remedy were, provided the remedy it ſelf reſulting from them be not ſo. And whereas it is objected, that in divers of theſe remedies the corroſive ſalts are not really deſtroyed, but only diſguiſed, becauſe by diſtillation it is poſſible to ſeparate from them the liquors uſed about them as corroſive as ever; it may eaſily be replied, that beſides that, in ſeveral medicines, the matter of fact will not hold in divers others, the objection built on it is much more ſpecious than ſolid: for it very little concerns us to be ſure, that out of the medicines we take or give, the violence of fire cannot ſeparate corroſive ſalts; provided we be duly ſatisfied, that no ſuch ſeparation can be made by the heat or juices of a human body. And therefore, though it have been affirmed, that tartarum vitriolatum would upon the urgent ſollicitation of a ſtrong fire, part with much of (that moſt fretting liquor upon animal ſubſtances) the oil of vitriol, that concurred to its production; yet our beſt and warieſt phyſicians, not only chymiſts but methodiſts, ſcruple not to give it inwardly in ſeveral conſtitutions and diſtempers. And to end this diſcourſe with the experiment, that began it, we clearly ſee, that ſalt-petre is frequently and innoxiouſly given inwardly, though the ſalt, that makes even aqua fortis ſo corroſive, be the principal ingredient of it, and may by diſtillation be driven from it.

SECT. XXXIX.

IT would not have been very uneaſy for me, *Pyrophilus*, to have added to divers particulars of the paſt diſcourſe, experiments and conſiderations tending to countenance or illuſtrate the reflections therein ſet down: but in the firſt place, I wanted leiſure to expatiate; in the ſecond place, I was unwilling to anticipate what I have to ſay to you in other eſſays, eſpecially expecting to have elſewhere occaſion to make mention of ſalt-petre. And beſides all this, I am (to tell you the truth) deſirous to impoſe on you a kind of neceſſity of proſecuting this experiment, further than, when I made it, I had opportunity to do. For as I am apt to think it may prove a noble one, ſo I am ſufficiently ſenſible of my having not yet been able to look into the bottom of it; and that very ſenſe of my own ignorance helped to keep me from lengthening your trouble in this eſſay, leſt by ſolemnly endeavouring to countenance my conjectures, I might be thought dogmatical in a haſty ſcribble, wherein it is much more my deſign to awaken and engage your curioſity, than acquaint you with my opinions. And yet I thought it not amiſs to mention the paſt conſiderations, ſuch as they are, partly becauſe this one inſtance ſeems ſo fairly to accommodate more than one notion of the intelligible philoſophy, which ſeems hitherto not to have ſo much as employed, much leſs produced, any ſtore of experiments; and partly, becauſe I would have you take notice, that more obſervables than one may ſometimes be very reaſonably ſought for in a ſingle experiment. And perhaps too, I was willing by my ſpending a whole eſſay upon one experiment, without allowing my ſelf to wander often from it, to invite you to think with me, that experiments ought to be eſtimated by their value, not their number; and that a ſingle experiment, I ſay not ſuch as that the laſt eſſay treats of, but in general, ſuch as, it may be, may as well deſerve an entire treatiſe, as a great many leſs conſiderable ones. As one of thoſe large and orient pearls, that are fit to adorn a monarch's crown, may out-value a very great number of thoſe little (though true) pearls, that are to be bought by the ounce in goldſmiths and apothecaries ſhops.

SECT. XL.

HAVING newly met, *Pyrophilus*, with ſome ſmall treatiſes freſhly publiſhed by *Glauberus*, and not having now the leiſure to conſider, or indeed ſo much as to peruſe; much leſs the opportunity to make trial of divers particulars, which by turning over the leaves of the book, I find mentioned by him in relation to ſalt-petre, I muſt recommend to you the care of examining the particulars he delivers; and trying how far ſome of them may ſerve to correct, or to confirm, and how far others may be

be corrected by what has been in the paſt diſcourſe ſet down concerning ſalt-petre upon experiments; ſome of whoſe fruits I can yet ſhew you, which were made upon the account of the diviſibleneſs of nitre into fixed and volatile parts, long before the publication of *Glauber*'s treatiſes.

THE

HISTORY

OF

FLUIDITY and FIRMNESS.

Advertiſements concerning the following Treatiſe.

THAT the author in thoſe animadverſions upon the *Eſſay touching Salt-petre*, whereof the enſuing treatiſe makes a part, might with the more freedom and conveniency add, alter, and even retract as he ſhould ſee cauſe, he thought fit to write them, as if they were made on the work of another.

THE author hopes, that the equitable reader, conſidering that the following particulars touching fluidity and firmneſs were firſt written but by way of annotations upon the beginning of the above-mentioned eſſay, will excuſe the unaccurateneſs of the method, as a fault ſcarce evitable on that occaſion. It is alſo hoped, that if the reader will remember, that he was told in the preface to the newly-mentioned eſſay, that moſt of thoſe, whom to gratify that treatiſe and the enſuing notes on it were written, were addicted to the Epicurean philoſophy; the author's explicating things chiefly according to the atomical principles will not be thought ſtrange, nor be looked upon as a ſure argument of his being wedded to the particular opinions, wherein the Atomiſts differ from other modern Naturaliſts: eſpecially, ſince he has on ſome occaſions plainly enough intimated the contrary, by propoſing, together with the atomical ways of reſolving a thing, another explication more agreeable to the Carteſian, or ſome other modern hypotheſis.

THE following tract was entitled, *A Hiſtory of Fluidity and Firmneſs*, becauſe indeed the having ſet down experiments and other matters of fact relating to the ſubjects treated of is the main, though not the only thing the author dares pretend to have done in it. And he ſtyles the hiſtory, as it now comes abroad, *Begun*; partly, becauſe he would invite abler pens to contribute their obſervations towards the compleating of what he is ſenſible he has but begun; and partly becauſe he may hereafter, if God permit, do ſomething of that kind himſelf.

AND laſtly, the author, though troubled that he can do it, dares not but advertiſe the reader, that ſome pages, partly a little after the beginning, and partly about the middle of the following treatiſe, having been loſt through the negligence or miſtake of him, to whoſe care the ſheets, whereon it was written, were committed; he fears he has not been able, otherwiſe than very lamely and imperfectly, to repair that loſs out of his memory.

THE

Hiſtory of FLUIDITY and FIRMNESS.

The Firſt Part.

Of FLUIDITY.

SECT. I.

WHETHER philoſophers might not have done better in making fluidity and firmneſs rather ſtates than qualities of bodies, we will not now examine. But under which ſoever of the two notions we look upon them, it is manifeſt enough, that they are to be reckoned amongſt the moſt general affections of the conventions or aſſociations of ſeveral particles of matter into bodies of any certain denomination, there being ſcarce any diſtinct portion of matter in the world, that is not either fluid, or elſe ſtable or conſiſtent. And therefore, I preſume, it may be well worth while to conſider, what may be the general cauſes of theſe two ſtates, qualities, or affections of matter; and to try, whether by aſſociating chymical experiments to philoſophical

notions, there may not be given at leaſt a more intelligible and more practical of both theſe ſubjects, than has been hitherto afforded us by the doctrine of the ſchools, which is wont to appear very unſatisfactory to diſcerning men; many of whom look upon what is wont to be taught by the Peripateticks, concerning fluidity and firmneſs, as well as other qualities, to be partly too general to teach us much, and partly too obſcure to be underſtood. And that which at preſent invites us to this inquiry is, chiefly, that ſome circumſtances of our author's experiment, touching ſalt-petre, may afford us ſome uſeful aſſiſtance in our deſigned ſearch. For though the chief phænomena and circumſtances of the experiment may be thought principally to reſpect fluidity; yet ſince that and firmneſs are contrary qualities, and ſince it is truly, as well as commonly, ſaid, that contraries ſurveyed together ſerve to illuſtrate each other, it may reaſonably be hoped, that the circumſtances juſt now related may give to the nature of fluidity, may facilitate the knowledge of that of compactneſs: nevertheleſs, we ſhall often be obliged to treat of theſe two qualities together, becauſe the experiments we are to produce do many of them relate to both.

SECT. II.

A BODY then ſeems to be fluid, chiefly upon this account, that it conſiſts of corpuſcles, that touching one another in ſome parts only of their ſurfaces (and ſo being incontiguous in the reſt) and ſeparately agitated to and fro, can by reaſon of the numerous pores or ſpaces neceſſarily left betwixt their incontiguous parts, eaſily glide along each other's ſuperficies, and by reaſon of their motion diffuſe themſelves, till they meet with ſome hard or reſiſting body; to whoſe internal ſurface, by virtue of that motion, their ſmallneſs, and either their gravity, or ſomething analogous or equivalent to it, they exquiſitely, as to ſenſe, accommodate themſelves.

SECT. III.

WHAT notion *Epicurus*, and the ancient Atomiſts his followers, had of fluid bodies, may be learned from theſe verſes of his paraphraſt *Lucretius:*

Illa autem debent ex lævibus atque rotundis
Eſſe magis, fluido quæ corpore liquida conſtant.
Nec retinentur enim inter ſe glomeramina quæque,
Et procurſus item in proclive volubilis extat.

And indeed, it is probable enough, that in divers liquors the little ſurfaces of the component particles are ſmooth and ſlippery, and that their being ſo does much facilitate the gliding of the corpuſcles among themſelves; and conſequently, the fluidity of the body they compoſe. Nor is it to be denied, that the ſpherical figure of ſuch corpuſcles may alſo conduce to their eaſy rolling upon one another: but there are divers other figures, which may make the little bodies endowed with them voluble enough to conſtitute a fluid ſubſtance. And the other qualities to be met with in divers liquid ſubſtances, and even in water itſelf; and oil, ſeem to argue their parts to be otherwiſe ſhaped; and thoſe fluid bodies, which are not liquors, as air and fire, ſeem to be compoſed of particles not all or moſt of them round, but of very various, and ſometimes of very irregular figures; and yet that ſuch bodies deſerve to be called fluid ones, will be manifeſt anon. And that they make a much more conſiderable part of the univerſe, than thoſe that are wont to be called liquors, may be argued from hence, that except the earth, the planets, and perhaps too the fixt ſtars, the reſt of the world, as vaſt as it is, ſeems to conſiſt chiefly, if not only, of an ætherial, thin, and fluid ſubſtance, as may appear (to omit other arguments) by what later aſtronomers have obſerved concerning the free and unreſiſted motion of ſuch comets as have by a trajection through the æther, for a long time wandered through the celeſtial or interſtellar part of the univerſe.

SECT. IV.

AND here let us obſerve, that it is not neceſſary to the fluidity of a body, nay, nor to its appearing fluid to the eye it ſelf, that the corpuſcles it conſiſts of be crouded as cloſe together as they are wont to be in water, and other bodies, that are commonly looked upon as the only liquors. For though a parcel of matter no bigger than a grain of corn, being rarified into ſmoke, will poſſeſs an incomparably greater ſpace than it did before; and though, if a body be further rarified into flame, its expanſion will be yet much greater: yet both ſmoke and flame may be ſo ordered, as to appear like liquors. We have practiſed divers ways, to make the fumes of bodies acquire a viſibly-level ſuperficies like water; but the eaſieſt, though not perhaps the beſt, is this, (part of which I remember I have ſeen performed as a kind of trick by a very ingenious perſon:) The mouth being filled with the ſmoke of roſemary (that happening to be at hand when I made the experiment) if this ſmoke be plentifully blown into a glaſs pipe of an indifferent ſize, and open at both ends; and if when it is well filled with ſmoke, the lower end be preſently ſtopt, and the glaſs be kept ſtill a while in an erected poſture, the fumes will ſettle by degrees to a level ſuperficies like water: ſo that, though you gently incline the pipe any way, the upper ſurface of the ſmoke will nevertheleſs quickly grow parallel to the horizon. And if the glaſs be further (but ſlowly) made to ſtoop, the ſmoke will ſeem to run down in a body like water, whilſt it continues in the pipe; though when it is come to the lower end of it, inſtead of dropping down like water, it will commonly rather fly upwards, and diſperſe it ſelf into the air. And as for flame, I foreſee I ſhall ere long have occaſion to mention an experiment, whereby I have ſometimes endeavoured to ſhew, that even two contiguous flames, as expanded bodies as they are, and as open as their texture is, may like viſible fluids of a differing kind retain diſtinct ſurfaces.

SECT. V.

BUT inſtead of examining any further, how many bodies are or may be made viſibly to appear fluid ones; let us now reſume the conſideration of what it is that makes bodies fluid: eſpecially, ſince having intimated ſome of the reaſons, why we are unwilling to confine our ſelves to the Epicurean notion, we hope it will the leſs be diſliked, that we thought fit to make ſuch a deſcription of a fluid ſubſtance, as may intimate, that we conceive the conditions of it to be chiefly theſe three.

THE firſt is the littleneſs of the bodies that compoſe it: for in big parcels of matter, beſides the greater inequalities or roughneſſes, that are uſual upon their ſurfaces, and may hinder the eaſy ſliding of thoſe bodies along one another; and beſides that divers other affections of a fluid body cannot well belong to an aggregate of groſs lumps of matter; beſides theſe things, I ſay, the bulk it ſelf is apt to make them ſo heavy, that they cannot be agitated by the power of thoſe cauſes (whatever they be) that make the minute parts of fluid bodies move ſo freely up and down among themſelves: whereas it would ſcarce be believed, how much the ſmallneſs of parts may facilitate their being eaſily put into motion, and kept in it, if we were not able to confirm it by chymical experiments. But we ſee that lead, quick-ſilver, and even gold it ſelf, though whilſt they are of a ſenſible bulk, they will readily ſink to the bottom of aqua regis, or any other ſuch liquor; yet when the menſtruum has corroded them, or fretted them aſunder into very minute parts, thoſe minute corpuſcles grow then ſo much more capable of agitation than before, that quitting the bottom of the liquor, they are carried freely every way, and to the top, with the aſſociated parts of the liquor, without falling back again to the bottom. Nay, we ſee, that ponderous and mineral bodies divided into corpuſcles ſmall enough may be made ſo light and voluble, as to become ingredients even of diſtilled liquors; as we may learn by what ſome chymiſts call the butter, others (ſimply) the oil, and others the *oleum glaciale* of antimony; which, though it be after rectification a very limpid liquor, yet does in great part conſiſt of the very body of the antimony, as may appear (not to mention its weight) by this, that it is moſt eaſy to precipitate out of it with fair water ſtore of a ponderous white calx, reducible by art to an antimonial glaſs. Nay, we make a menſtruum, with which we can eaſily at the firſt or ſecond diſtillation bring over gold enough, to make the diſtilled liquor appear and continue enobled with a golden colour.

AND to ſhow yet more particularly, that great bodies are too unwieldy to conſtitute fluid ones; we may further obſerve, how as well nature as art, when either of them makes bodies of conſiderable bulk fluid, is wont, in order thereunto, to make a comminution of them, as we may obſerve in divers examples.

SECT. VI.

THUS we ſee, that in the ſtomachs of dogs, nature, to reduce bones into thoſe fluid bodies, chyle and blood, does by ſome powerful and appropriated juice, (whether belonging to the ſtomach it ſelf, or thrown out of the arteries in the paſſage of the circulating blood) diſſolve them into parts ſo minute, that the acuteſt eye would not tempt a man to ſuſpect, that ſuch a liquor had ever been a bone. And that it may not be objected, that this diſſolution is chiefly performed, or at leaſt muſt always be aſſiſted by the liquor, which animals take into their ſtomachs by drinking; I ſhall repreſent not only, that we find by experience, how little common water, the only uſual drink of dogs, wolves, *&c.* is able to diſſolve bones, though they be very long not macerated, but boiled in it; but that (if we may believe natural hiſtorians and credible travellers) there are ſome ſorts of animals, as particularly camels, that may be brought not to drink once in many days, even when they travel in hot climates. And to make you think this the leſs improbable, I ſhall add, that I am familiarly acquainted with an ingenious gentleman, who, as himſelf and an ancient virtuoſo, in whoſe houſe he lives, have informed me, does uſually drink but once in ſeveral days, and then no exceſſive draught neither. And when I aſked him, how long he had actually abſtained not barely from drink, but from thirſting after it? he anſwered, that he had once (ſome few years before) continued about nine days without either taking or needing any drink; and he doubted not, but that he might have continued much longer in that ſtate, if by diſtempering himſelf one night with long and hard ſtudy he had not had ſome light inclination to take a ſmall draught, which ſerved him for about four days longer. And when I aſked him, whether in that hot ſummer's-day, that preceded the evening, wherein he happened to tell me this, he had not drunk at all? he anſwered negatively. And it adds to the ſtrangeneſs of this peculiarity, that this gentleman is in the flower of his youth, being but about twenty two years of age, and of a ſanguine and florid complexion. And (to annex that alſo upon the by) I learned by inquiry from him, that he ſweats freely enough, as I remember I ſaw him do; that his diet is the ſame with other men's, without reſtraining him from the free uſe of ſalt meats; and that his urine is in quantity much like that of ordinary men of his age and temperament. But to return to what I was ſaying more generally of the ſtomachical menſtruum of animals; I ſhall add on this occaſion, that to make ſome kind of imitation of it, I prepared, and do elſewhere mention and teach a certain liquor, that I uſe, whereby I have in a ſhort time, and without fire, diſſociated the parts of roaſted or boiled fleſh, bread, fruit, *&c.* and pulled them aſunder into very minute bodies, whereby I have reduced ſometimes one, ſometimes another of them, together with the menſtruum, (which needs not much exceed them in bulk) to the conſiſtence of a fluid body.

WE ſee likewiſe, that fuſion makes metals fluid, and in fuſion there is manifeſtly a comminution of the melted body; the heat alone of gold, ſilver, or iron, though increaſed even

to

to ignition, being not able to make thoſe metals become fluid, whilſt they continue in maſſes of any ſenſible bulk. To which I ſhall add anon, that even melted metals may have their fluidity increaſed by a yet further comminution of their parts.

SECT. VII.

AND to reſume here the conſideration of that very difficult queſtion, which we have elſewhere mentioned, it ſeems well worth inquiry, whence it happens, that in the diſtillation of common ſalt and other ſaline bodies, which not only are not fluid, but are hard even to brittleneſs, there will yet be obtained a perfect and permanent liquor, and from ſome of them a very conſiderable proportion of it. In anſwer to this queſtion it may indeed be ſaid, that in divers dry bodies, ſuch as harts-horn, wood and bones, committed to diſtillation, the fire does no more than ſeparate the aqueous or other liquid parts from the others, wherewith they were blended in the concrete, and bring them together into the receiver, where they convene into a liquor. But beſides that this it ſelf is perhaps more eaſily ſaid than proved, it does not reach the propounded difficulty: for with what probability can it be affirmed of bodies, that have been already calcined or melted? ſuch as are the red calx of vitriol, and fluxed ſea-ſalt, *&c.* which yet afford liquors, though their aqueous and other looſer parts have been already driven away by a ſtrong fire before their being expoſed to diſtillation. I have ſometimes then conſidered, whether it may not ſeem leſs improbable to conjecture, that the vehement agitation produced in ſuch bodies by the violence of heat does both divide them into minute corpuſcles, and drive over ſwarms of them into the cold receiver, where loſing their former vehemence of agitation, they are reduced into a liquor, chiefly, (for I would not exclude concurrent cauſes) by reaſon that the fire happened to rend the concrete into parts, by their extreme littleneſs, or their ſhape, or both, ſo eaſy to be tumbled up and down, that the wonted agitation of the air, propagated by the interpoſed bodies or medium, or elſe that the ſame cauſe, whatever it be, that gives the air its wonted agitation, is able to give ſuch minute corpuſcles enough of it to keep them fluid.

SECT. VIII.

THAT there is conſtantly in the air a various motion of the ſmall parts, will be anon declared. That alſo ſome bodies will be kept fluid by a much leſs meaſure of agitation than is requiſite to others, ſeems probable from hence, that wine will continue a liquor in ſuch a languid warmth of the air, as will not keep the parts of water moving, but permit them to reſt in the form of ice. And in cold countries, where wine it ſelf would congeal, (as I have by art made it do here in *England*) it is obſerved, that though the more aqueous parts will by the loſs of their motion be turned into ice, yet the more ſubtile and ſpirituous parts remain unfrozen; and ſo do divers other liquors, (eſpecially chymical) of very ſubtile and voluble parts. And the corpuſcles, that chiefly compoſe that body, which is properly called the air, though it appears by weather-glaſſes, that cold may very much contribute to condenſe it, (that is, to occaſion the approach of its parts to one another, or, reduce them to a cloſer order) have not been obſerved to be frozen by any degree of cold whatſoever; which ſeems to proceed from hence, that by reaſon of their extreme littleneſs, (not excluding their figure) there cannot be ſo little of agitation about the earth, as not to be ſufficient to continue a various motion in ſuch very minute bodies, and conſequently to keep them fluid.

Now, that likewiſe it is poſſible, that a ſaline ſpirit ſhould conſiſt at leaſt in great part of very minute grains of ſalt, we elſewhere declare; where it is taught, that a ſal-armoniac may be made by ſpirit of urine and ſpirit of ſalt, as the common ſal-armoniac is made with crude ſalt: and there a way is alſo ſhewn, how theſe two ſalts, (the urinous and the other) as ſtrictly as they are united in the compound, may be readily divorced. And agreeably to this I obſerve, that as (according to what I elſewhere note) a common aqua fortis may be enabled to diſſolve gold, (on which of it ſelf it will not faſten) by the addition of ſpirit of ſalt; ſo I find, that common crude ſalt barely diſſolved in it will give it the like power of working upon gold. Nay, I have tried, that crude nitre, diſſolved in good ſpirit of ſalt, may make it ſerve for an aqua regis. And I remember on this occaſion, that having inquired of the moſt noted perſon in *Holland* for the diſtilling of corroſive waters, what was the greateſt proportion of diſtilled liquors, that ever he was able to obtain from ſea-ſalt; he (though a man not given ſo much as to boaſting) affirmed to me, that by uſing inſtead of the ordinary *Caput mortuum*, as brick-duſt, ſand, *&c.* (that chymiſts are wont to mingle with ſalt before they diſtil it) a certain whitiſh clay, he had ſometimes brought over almoſt the whole body of ſalt into a liquor; inſomuch that from a pound of ſalt he could draw, and that without any extraordinary trouble or degree of fire, fourteen ounces of liquor. And when, becauſe I ſuſpected, that much of this might be water forced from the clay mingled with the ſalt, I inquired, whether he had ever dephlegmed this liquor; he anſwered me, that he had purpoſely done it; and ſometimes found no leſs than about twelve ounces of it to be ſtrong rectified ſpirit: which brought into my mind that almoſt incredible paſſage of *Beguinus*, who ſomewhere teaching the diſtillation of another ſalt, adds to the end of his directions, that if you have wrought well, you ſhall get from a pound of the matter a pound of ſpirit. But becauſe from all theſe liquors, diſtilled from ſuch kind of ſalts, it is poſſible either by rectification, or ſome more philoſophical way, to obtain a portion of phlegm or water, I leave it to further inquiry, whether or no the fluidity of theſe diſtilled liquors may not in divers caſes be in part furthered by the mixture of ſome particles of an aqueous nature, (ſuch being fit to make diſſolvers and vehicles for ſalts) which may not abſurdly

abſurdly be ſuſpected to have been produced by the action of the fire, upon the concrete committed to diſtillation; if we allow, with that famous chymiſt *Helmont*, that by the alkaheſt all groſs bodies may be totally, and that, without it, even oil and ſalt may in great part, (and that without additaments) be reduced into inſipid water.

SECT. IX.

WE ſhall anon, (when we come to treat of firmneſs) mention our having made a certain ſubſtance ſo diſpoſed to fluidity, that it may be made to change the ſtable conſiſtence for a liquid one, by ſo ſmall an agitation, as only the ſurpluſage of that, which the ambient air is wont to have about the middle even of a winter's-day, above what it hath in the firſt or latter part of it. Nay, we have made even a metalline ſalt or vitriol capable of this proclivity to liquefaction, of which we have unqueſtionable witneſſes. And therefore, it need not appear incredible, that other heaps or aggregates of corpuſcles much lighter than theſe, though heavier than thoſe of the air, may have all their parts ſo minute and fitted for motion, that the wonted agitation of the air may not only about noon, but at all other times of the day, keep them in motion, and thereby in the ſtate of fluidity.

SECT. X.

AND here I muſt add, that it was not altogether without cauſe, that I lately took notice of the ſhapes as well as the ſizes of bodies, in reference to their fitneſs to conſtitute fluid ones. For though I be not ſure, but that in thoſe bodies, as ſal-armoniac, antimony, *&c.* which are by the fire ſublimed into flowers rather than diſtilled into liquors, the magnitude of the component corpuſcles may not be a hinderance to the fluidity of the body they conſtitute; yet this ſeems as probably referable to their figure, unapt for the requiſite motion, as to their bulk. And I have ſometimes made to this purpoſe this experiment; that by ſlowly diſtilling oil-olive *per ſe* in a glaſs-retort, (placed in ſand) I found, as I expected, that about the third part of the oil, which was driven over into the receiver, did there coagulate into a whitiſh body almoſt like butter. So that although it ſeemed manifeſt by the ſtrong ſmell and very piercing taſte of this white ſubſtance, that the oil, which afforded it, had its particles, as it were, torn in pieces; and though diſtillation be wont to obtain liquors even from conſiſtent bodies; yet in our experiment of a concrete, that is naturally fluid, the diſtilled liquor it ſelf proves not to be ſo: of which no cauſe ſeems more obvious, than that the newly-acquired ſhape of the diſſipated parts of the oily corpuſcles makes them unfit for motion; either abſolutely ſpeaking, or at leaſt in reſpect of one another, by making them leſs pliant than formerly, or giving them a figure more eaſy to be entangled with the neighbouring corpuſcles, or elſe by making their ſurfaces leſs ſmooth and ſlippery than before.

SECT. XI.

BUT to return thither, whence we have digreſſed, and mention ſome more familiar examples of the conduciveneſs of the ſmallneſs of a body's disjoined parts to its fluidity, we may take notice, that of bodies, that conſiſt of incoherent parts, and are made up, as it were, by aggregation, thoſe *de cæteris partibus*, in their being poured out, moſt reſemble liquors, that are the ſmalleſt; as would appear upon the emptying of ſeveral ſacks, the one of apples, the other of walnuts, the third of filberts, the fourth of corn, the fifth of ſand, and the ſixth of flour.

CONFECTIONERS alſo, cooks, and others, that make much uſe of whites of eggs, will eaſily reduce thoſe clammy and viſcous bodies into a thin and fluid ſubſtance, to which, for its affinity with water, many give the ſame name: and yet this difference of fluidity being effected only by long and ſkilfully beating the maſs with a whiſk, or even with a ſpoon, ſeems to be produced but by pulling aſunder the parts, (which, perhaps, before were long and ſomewhat twined) and breaking them into ſhorter or leſſer, and conſequently more voluble ones. And I remember, I have ſeen a good quantity of that jelly, that is ſometimes found on the ground, and by the vulgar called a ſtar-ſhoot, as if it remained upon the extinction of a falling ſtar, which being brought to an eminent phyſician of my acquaintance, he lightly digeſted it in a well-ſtopt glaſs for a long time, and by that alone reſolved it into a permanent liquor, which he extols as a ſpecifick to be outwardly applied againſt wens.

SECT. XII.

AND here we will ſubjoin an obſervation afforded us by the art of caſting, which has ſometimes yielded us a not unpleaſant diverſion. It is obſerved then by goldſmiths well verſed in that art, (and has been recommended to me by an artificer eminently ſkilful in it) as one of the chief remarks belonging to it; that when any ſuch curious work of ſilver is to be caſt, as requires, that the impreſſion of hairs or very ſlender lines be taken off by the metal, it is not enough, that the ſilver be barely melted; but it muſt be kept a conſiderable while in a ſtrong fuſion: for if it be too ſoon poured out, the figure it will make will be but blunt; whereas if it be kept a competent time in fuſion, the matter becoming thereby more liquid as well as hotter, will be thin enough to run into the ſmalleſt cavities of the mould, and ſo receive a figuration even from the delicateſt of them. Whence it may probably be deduced, that ſome bodies already fluid may, by a further comminution of their parts, be made yet more fluid. The like increaſe of fluidity may be obſerved in ſome other fluid bodies, eſpecially unctuous ones, as turpentine, oil, *&c.* when heat begins to break as well as agitate their parts.

I MAY elſewhere have occaſion to mention, how, by the operation of the fire, the cryſtalline, ſalt of urine may be reduced without additaments.

ments to a ſtrong and ponderous liquor: though in this, as perhaps alſo in ſome of the former inſtances, it is not unlikely, that (as we may hereafter more particularly declare) there may concur to the produced change of conſiſtence ſome alteration in the figure of the corpuſcles, whereof the firm body conſiſted.

AND if that be true, which *Helmont* in ſeveral places affirms of his prodigious liquor, alkaheſt, it is poſſible to turn plants, animals, ſtones, minerals, metals, or whatever kind you pleaſe of conſiſtent body here below, into a liquor equiponderant to the reſolved concrete: which (if granted) ſeems to argue, that the moſt ſolid body, by being divided into parts ſmall enough to be put into motion by the cauſes, that keep thoſe of water and other liquors in agitation, may become fluid bodies. And this intimation I ſhall add for the ſake of philoſophers, that barely by long digeſtions, (and much more if they be helped by ſeaſonably-repeated diſtillations) in exactly ſtopt veſſels, and a due degree of heat, there may be made in the parts of many bodies, both vegetable and animal, ſo great a change from the ſtate of conſiſtence to that of fluidity, as thoſe, that contenting themſelves with ordinary courſes of chymiſtry, have not had a peculiar curioſity for trials of this nature, will not be forward to expect.

SECT. XIII.

THE ſecond of the above-mentioned three conditions is, that there be ſtore of vacant ſpaces intercepted betwixt the component particles of the fluid body, or at leaſt about thoſe of them, that are ſuperficial: for without this there will not be room for each of the corpuſcles to continue its agitation upon the ſurfaces of the neighbouring ones; and there would be no ceſſion of any, becauſe there would be no place unpoſſeſſed for the impelled corpuſcle to be received in. But when I ſpeak of vacant ſpaces, ordinarily, (if not always) requiſite to be intercepted betwixt the particles of fluid bodies; I intend not to determine, whether or no ſuch ſpaces ſhould or may be vacuities properly ſo called; it being commonly ſufficient to this ſecond condition of a fluid body, that in the little ſpaces intercepted between thoſe that either are, or at leaſt are conſidered as ſolid parts, there be none but ſuch as will eaſily yield to them, and cannot conſiderably reſiſt the freedom of their motions.

WHICH being premiſed to keep this condition from being miſtaken, we may in confirmation of it take notice, how ſnow, which at its firſt falling is of a looſe and open texture, does eaſily yield to the impreſſions of the hand: but when by being ſtrongly compreſſed and formed into balls, the little icy bodies it conſiſts of are brought into a cloſer order, and many of them thruſt into the little ſpaces formerly poſſeſſed only by the yielding air, they become unable to give way to the motions of our hand as before, but compoſe a hard and reſiſting body. We ſee alſo, that when water is ſtrongly forced into and kept compreſſed in a bladder, ſo that its exteriour particles have not about them as before the yielding air to give way to them, when they ſhould, according to their wont, ſwell about the ſides of the bodies that endeavour to preſs it inwards, it emulates a hard body, and reſiſts ſuch motions as otherwiſe it would readily yield to; unleſs a more eaſy ceſſion be occaſioned by the retching of the moiſtened bladder it ſelf.

AND I chuſe to inſtance in a bladder diſtended with water, rather than in one full of air, becauſe, though this latter will alſo emulate a hard body, yet in this caſe the tenſion of the bladder would perhaps be aſcribed to a kind of ſpring, which divers experiments have taught us to belong to the air: whence it might be ſaid, that ſince the incloſed air will ſuffer it ſelf to be thruſt inward a good way, though it will quickly when permitted fly out again; the hardneſs of a well-blown bladder proceeds not from want of the rooms requiſite to the ceſſion of the aërial corpuſcles, but to the motion of reſtitution natural to them; when like an innumerable company of little bows or ſprings, being bent by the force, that compreſſes the ſides of the bladder, they do, as ſoon as it is taken off, ſtretch themſelves out again (ſome one way, ſome another) as far as is permitted them by the impriſoning bladder, which they thus every way keep ſtrongly diſtended.

BUT this having of vacant ſpaces, or ſome yielding matter about the corpuſcles of a fluid body, ſeems requiſite to its being ſo, but as what in a ſchool-term one may call a *Removens prohibens*; I mean, only as it obviates that impediment to their motion, which exquiſite fulneſs may be conceived to give to the various glidings amongſt themſelves of the parts of a body ſuppoſed to be perfectly of the ſame hardneſs or ſoftneſs, or, if you pleaſe, altogether equally diſpoſed or indiſpoſed to yield to one another. And although in ſuch bodies, as water, wine, oil, quickſilver, and the like, that are generally agreed upon to be fluid liquors, it will I preſume be granted, that this ſecond condition we have been ſpeaking of may take place; yet I will not ſay, that it were altogether abſurd to queſtion, whether there may not be a portion of matter conſiſting of parts ſo minute, and ſo agitated, and conſequently ſo eaſy to be either crumbled into yet ſmaller parts, or ſqueezed into any figure as occaſion requires, that they may inceſſantly change places among themſelves, and thereby conſtitute a moſt fluid body, without any vacuities, receptacles, or yielding matter about them, unleſs perhaps it be about the exteriour parts of thoſe of them, that from time to time happen to be the ſuperficial corpuſcles of this thinneſt liquor. But though we have ſaid, that this may be queſtioned without abſurdity, yet it will not ſo much concern us in this place to examine, whether the affirmative may be rationally maintained, as to proceed to conſider what is farther requiſite to that ſtate of matter we are now treating of, eſpecially the qualification yet unmentioned ſeeming to be the principal of all.

SECT. XIV.

FOR the third and chief condition of a fluid

body is, that the particles it conſiſts of be agitated variouſly and apart, whether by their own innate and inherent motion, or by ſome thinner ſubſtance, that tumbles them about in its paſſage through them. For this ſeems to be the main difference betwixt ſolid ice and fluid water, that in the one the parts (whether by any newly acquired texture, or for want of ſufficient heat to keep them in motion) being at reſt againſt one another, reſiſt thoſe endeavours of our fingers to diſplace them, to which in the other, the parts being already in motion, eaſily give way. For whereas in the ice, every part actually at reſt muſt by the law of nature continue ſo, till it be put out of it by an external force capable to ſurmount its reſiſtance to a change of its preſent ſtate; in water each corpuſcle being actually (though but ſlowly) moved, we need not begin or produce a new motion in it, but only byaſs or direct that, which it has already, which many familiar inſtances manifeſt to be a much eaſier taſk. From this agitation of the ſmall parts of liquors it comes to paſs, that theſe little bodies, to continue their motion, do almoſt inceſſantly change places, and glide ſometimes over, ſometimes under, and ſometimes by the ſides of one another. Hence alſo may be rendered a reaſon of the ſoftneſs of fluid bodies, that is, their yielding to the touch: for the particles that compoſe them being ſmall, incoherent, and variouſly moved, it can be no difficult matter (as we lately intimated) to thruſt them out of thoſe places, which being already in motion they were diſpoſed to quit, eſpecially there being vacant rooms at hand, ready to admit them as ſoon as they are diſplaced. And hence it likewiſe happens, that theſe little bodies muſt be very eaſily moveable any way upon the motion of the maſs or liquor, which they compoſe; and that being very ſmall, and moving ſo many ways, they cannot but (according to *Ariſtotle*'s definition of things fluid) be very unfit to bound themſelves, but very eaſy to be bounded by any other firm body; for that hinders them from ſpreading any further: and yet to continue their various and diffuſive motion as much as they can, (eſpecially their gravity, at leaſt here about the earth, equally depreſſing and thereby levelling as to ſenſe their uppermoſt ſuperficies) they muſt neceſſarily move to and fro, till their progreſs be ſtopped by the internal ſurface of the veſſel, which by terminating their progreſs (or motion toward the ſame part) does conſequently neceſſitate the liquor thoſe little bodies compoſe, to accommodate it ſelf exactly (for aught the eye is able to diſcern to the contrary) to its own figure.

SECT. XV.

THIS ſhort and general account of fluidity may, we hope, be as well further explicated and illuſtrated, as confirmed, by the following inſtances and experiments; and therefore we ſhall forthwith proceed to them.

AND it will be fit to mention in the firſt place thoſe, that are affordedus by the body our author treats of, ſalt-petre; they having occaſioned our writing about this ſubject.

SALT-PETRE then may be made fluid two ſeveral ways, either by, or without a liquor.

BY the intervention of a liquor it puts on the form of a fluid body, when being diſſolved in water or aqueous juices, it is not by the eye diſtinguiſhable from the ſolvent body, and appears as fluid as it; which ſeems to proceed from hence, that the agitated particles of the water piercing into the joints or commiſſures of the corpuſcles of the ſalt, do disjoin them, and thereby divide the nitre into parts ſo ſmall, that it is eaſy for thoſe of the water, wherewith they are aſſociated, not only to ſupport them, but move them to and fro: whence it comes to paſs, that theſe particles be ſo ſmall, and ſwimming ſome one way, ſome another in the yielding body of water, make no ſuch reſiſtance againſt the motion either of a man's hand, or other external body, that ſtrives to diſplace them, as they did in their ſaline form.

BUT that with much leſs liquor a nitrous body may be rendered fluid, may appear to him, that ſhall expoſe ſuch fixed nitre, as our author teaches to make, to the moiſt air of a cellar: for there it will run *per deliquium*, (as chymiſts ſpeak) into a liquor, which conſiſts of no more aqueous particles, than are neceſſary to keep the ſaline ones (which ſeem to be much ſmaller than thoſe of unanalyzed nitre) in the agitation requiſite to fluidity.

SECT. XVI.

AND hence we may proceed to conſider, what fluidity ſalt-petre is capable of without the intercurrence of a liquor: and this may be two-fold. For firſt, if it be beaten into an impalpable powder, this powder, when it is poured out, will emulate a liquor, by reaſon that the ſmallneſs and incoherence of the parts do both make them eaſy to be put into motion, and make the pores they intercept ſo ſmall, that they ſeem not at a diſtance to interrupt the unity or continuity of the maſs or body. But this is but an imperfect fluidity, both becauſe the little grains or corpuſcles of ſalt, though eaſily enough moveable, are not always in actual motion; and becauſe they continue yet ſo big, that both they and the ſpaces intercepted betwixt them are, near at hand, perceivable by ſenſe. But if with a ſtrong fire you melt this powdered nitre, then each of the ſaline corpuſcles being ſub-divided into I know not how many others, and theſe inſenſible parts being variouſly agitated by the ſame heat, (both which may appear by their oftentimes piercing the crucible after fuſion, wherein they lay very quietly before it) the whole body will appear a perfect liquor, and be thought ſuch by any beholder, that ſhall judge of it but by the eye: and ſuch alſo is the fluidity of melted metals, in which, when they are brought to fuſion in vaſt quantities, I have ſeen the ſurface waved like that of boiling water, and ſometimes parcels of liquor thrown up a pretty way into the air. And not only fire, and other actually and manifeſtly hot bodies,

dies; are able to make ſome hard ones fluid, but it ſeems alſo, that ſome bodies may be brought to fluidity by others, which to the touch appear cold, if they be but fitted to change the texture of the hard body, and put its inflected parts into a convenient motion; as may be ſeen in the chymical experiment of turning the brittle body of camphire into an oil for the time, by letting it lie upon aqua fortis, which perhaps bends and complicates the formerly rigid particles, and puts them into ſuch a motion, that they do as well glide along as ſomewhat twine about each other. And I further tried, (not having found it mentioned by the chymiſts) that camphire may by a dexterous application of heat be brought in cloſe glaſſes, both to flow, and to boil almoſt like oil. It is true, that theſe liquors taken from the fire quickly loſe that name, and grow ſolid again. But the durationof a thing is not always neceſſary to denominate it ſuch; for the leaf of a tree, for inſtance, whilſt it flouriſhes, may be as truly green as an emerald, though the leaf will after a while wither and turn yellow, which the ſtone will never do: and in cold climates, where lakes, *&c.* at other times navigable, are ſometimes frozen ſo hard, that carts and even great ordnance may ſafely be drawn over them, ice and water are the one a ſtable, and the other a liquid body, notwithſtanding that the ſame portion of matter, which at one time is frozen into a hard and ſolid ſubſtance, was a little before a fluid body, and (now and then in a very ſhort time) will be thawed into a liquor again.

SECT. XVII.

I KNOW not whether it be requiſite to take notice, that the fluidity, which ſalt-petre acquires upon fuſion by fire, ſeems very much of kin to that, which is acquired by ſolution in water. But if fuſion be made rather by the ingreſs and tranſcurſions of the atoms of fire themſelves, than by the bare propagation of that motion, with which the agitated particles that compoſe fire beat upon the out-ſide of the veſſels, that contain the matter to be melted; in ſuch caſe, I ſay, both thoſe kinds or manners of fluidity newly aſcribed to ſalt-petre will appear to be cauſed by the pervaſion of a foreign body: only in diſſolution the fluid body is a viſible and palpable liquor, and conſequently more groſs, whereas in fuſion the fluid ſubſtance that permeates it is more thin and ſubtil, and divides it into much ſmaller parts, and ſo adds very little to its bulk.

SECT. XVIII.

But becauſe ſome ſcruple may poſſibly ariſe about this matter from hence, that the powder of nitre, how fine ſoever, ſeems fluid but juſt whilſt it is pouring out, and even then is but very imperfectly ſo; and that as for fuſion, that is wont to reduce the melted body to a new and permanent ſtate, as the formerly-mentioned powder of ſalt-petre, which before fuſion was but a heap of incoherent particles, is by it made a ſolid and conſiderably hard body: to prevent, I ſay, or remove ſuch ſcruples, we will ſet down one experiment that we long ſince met with, as to the main, in the ſhops of ſtone-cutters, which, though unregarded by them, will excellently ſerve to make out what we mention it for. Take then good alabaſter, or in defect of this, of that white ſtone, which is well known to our maſons by the name of plaſter of *Paris*, beat it very ſmall, and put as many pounds as you pleaſe of the finely-fearced powder into any flat-bottomed (and firſt well heated) veſſel of braſs or iron, (bigger or leſſer according to the quantity you intend to burn.) Increaſe the fire by degrees, till it grow to be ſtrong, and when the calorifick atoms ſhall have in ſufficient numbers pervaded the heap of powder, or, if you pleaſe, when the igneous corpuſcles have by their numerous and briſk ſtrokes upon the veſſel communicated by its means their agitation to the incloſed powder, and when by either of theſe ways, or both, the fire (which may alſo reſolve ſome of the more ſpirituous and exhalable parts, whereof diſtillation has ſhewn me, that alabaſter is not deſtitute, into vapours) ſhall have put the little bodies it conſiſts of into actual motion, (which will be quickly done) you ſhall ſee it aſſume the form of a liquor, and boil with numerous great and confuſed waves juſt like a ſeething-pot. And if, whilſt it continues in this ſtate, you ſtir it with a ſtick, it will not like a heap of ſand, or, as itſelf would do at another time, reſiſt the motion thereof, but yield thereto like a liquor, and, like it, will ſeem to have ſomething of the nature of a coherent body: for by ſtirring it any thing ſtrongly near one ſide of the veſſel, you may make the waves beat very manifeſtly againſt the oppoſite part of it. And beſides all this, you may obſerve this further reſemblance betwixt this boiling matter and a liquor, that there will fly up out of the pot great ſtore of ſteams like ſmoke, but that they are white, which will ſometimes like ſmoke aſcend, for aught can be diſcerned, to the very top of the chimney, and leave its colour upon the places by which plenty of it hath paſt. Beſides, thoſe, that make this experiment often, as we have taken pleaſure to do, may have the opportunity to obſerve, that when the veſſel has continued ſo long over the fire, that the contained alabaſter relapſes into the form of a heavy moveleſs powder, by keeping it a while longer in the heat, it will for once at leaſt reſume the form of a fluid body, and boil again as before; the ſpirituous ſteams, whoſe avolation promoted the ebullition, being not yet quite ſpent. And laſtly, if when it ſeems moſt a liquor, you take up a little of it, and, as nimbly as you can, caſt it upon a ſheet of white paper, it will not at all wet it, but immediately diſcover itſelf to be a moveleſs incoherent powder, as it was before its being ſet over the fire. Whereby it (I hope) appears, that a heap or aggregate of ſuch little bodies as are neither ſpherical nor otherwiſe regularly ſhaped, nor ſmall enough to be below the diſcernment of the eye, may, without either fuſion or being poured out, be made fluid barely by a ſufficiently ſtrong and various agitation (from what cauſe ſoever that proceed)

of the particles that make it up, and loſe its fluidity immediately upon the ceaſing of it.

THUS have we ſeen, how very much it conduces to the making of a body fluid, that its ſmall parts be actually moved. But whence this motion proceeds, we ſhall not at preſent venture to determine. For though in the examples newly mentioned, and ſome others, moſt men will be forward to aſcribe the motion produced in the parts of the fluid bodies there mentioned, to the action of the fire, whereunto they were expoſed; yet what it is, that puts the parts of fluid bodies in general into the motion requiſite to make them ſuch, is a queſtion, of which the true reſolution indeed were very deſirable. But the full debate of it will not, I hope, be here expected from me, whilſt I am writing but notes, ſince it would engage me to diſcuſs two or three of the difficulteſt as well as the importanteſt controverſies belonging to natural philoſophy. For firſt, I ſhould be obliged to conſider whether motion, or a propenſity to it, be an inherent quality belonging to atoms in general, and not loſable by them; or whether all motion is communicated by impulſe from one body to another. And ſince thoſe, that of late have taught, that all viſible liquors, as water, oil, quick-ſilver, *&c.* owe their fluidity chiefly to the agitation of ſome thin and reſtleſs matter, which inceſſantly permeates them, do deduce the neceſſity of ſuch an ethereal ſubſtance principally from the impoſſibility, that there can be any vacuum properly ſo called in the univerſe, wherein yet are very many ſpaces unpoſſeſſed by either air or groſſer bodies than it: the examination of this ſubtile matter would draw on the conſideration of the nice controverſies, that perplex philoſophers concerning emptineſs, which it were more difficult for us to examine in few words, than it is neceſſary for us to meddle with them in this place; ſince not writing of the firſt principles of phyſiology, but of fluidity, which is but a ſecondary or derivative quality (if I may ſo call it) it ſeems ſufficient to give a notion of it, that we deduce it not from the unintelligible ſubſtantial form of the fluid bodies, but from thoſe ſimple and general affections of matter, the figure, ſituation, and motion of its ſmall parts.

SECT. XIX.

WHEREFORE declining to add any thing in this place to what we have otherwhere diſcourſed concerning the origin of motion, and the poſſibility or impoſſibility of a vacuum; we will proceed to take notice, that there is one thing more, which we may learn from ſalt-petre touching the nature of fluidity, and that is the diſtinction betwixt a fluid body and a wetting liquor, which are wont, becauſe they agree in many things, to be confounded, but inconſiderately enough: for though every wetting liquor be fluid, yet every fluid body does not wet. The air, the æther, and even flame it ſelf may be properly called fluid bodies, according to the notion of fluidity hitherto made out, and yet will ſcarce by any man be called moiſt liquors; and ſalt-petre, whilſt in fuſion, is really a liquor, and ſo is every melted metal; and yet theſe wet not the bodies they touch, as do water and other wetting liquors, which are fluid bodies with this peculiar qualification, that they ſtick to and moiſten the dry bodies, which they touch (or at leaſt abound with ſome parts, which being ſeparated from the reſt and reduced to a liquor, will do ſo.) And, according to this notion, methinks, it may be conceived, that the humidity of a body is but a relative thing, and depends chiefly upon the congruity or incongruence of the component particles of the liquor in reference to the pores of thoſe particular bodies, that it touches: for, ſometimes the little eminencies and pores of the ſurface of the dry body, on or againſt which the liquor flows, are of ſuch magnitudes and figure, that the particles of the liquor find admittance into thoſe pores, and are detained there (by which means they uſually ſoften it;) and ſometimes the pores and aſperities of the dry bodies ſurface are ſo incommenſurate in bigneſs and figure to the particles of the liquor, that they glide over the ſurface, without ſticking or adhering firmly to any part of it. This may be exemplified in quickſilver; which cannot be ſaid to be a humid body in reſpect of our hands or clothes, or of almoſt all other bodies of the world, upon whoſe ſurfaces it will roll without leaving any of its particles lodged in their pores, or faſtened to their little eminencies, whence it is called by vulgar chymiſts, the water, that wets not the hands: but in reference to divers metals, eſpecially gold and tin, quickſilver may be ſaid to be a humid liquor, for it inſinuates it ſelf into their pores, and thereby mollifies their bodies, as other liquors do thoſe, that are moiſtened by them. And even water, that wets almoſt all other animal and vegetable, and many mineral bodies, beſides that it is commonly enough obſerved to ſtand in almoſt globular drops upon cabbage-leaves, ſeems not a humid liquor in relation to the feathers of ducks, ſwans, and other water-fowl; whom nature having deſigned to fly ſometimes in the air, and live ſometimes in the water, ſhe providently makes their feathers of ſuch a texture, that they do not, like the feathers of divers other birds, admit the water, which imbibed would make them unfit for the uſe of flying. And it is obſervable, that upon the change of texture in a liquor, it may be brought to ſtick to the ſurface of a body, to which before it would not adhere; as may appear by this, that though quickſilver alone will not ſtick to glaſs, yet if there be mixt with it a due proportion of lead, tin, and tin-glaſs, though neither of them will adhere to glaſs, yet their liquid mixture (as we have often tried and elſewhere * taught) readily will, even without the aſſiſtance of heat.

SECT. XX.

IF it be objected, that this various agitation of the inſenſible parts of water and reſembling bodies,

* The writing here referred to, is the ſecond tome of *The Uſefulneſs of Experimental Philoſophy*, which ſhould have appeared before theſe ſpecimens.

bodies, wherein we make the nature of fluidity chiefly to consist, is but an imaginary thing, and but precariously asserted, since by our own confession they are so small, that the particles themselves, and more, the diversity of their motions are imperceptible by sense, which represents water, for example, to us as one continued body, whose parts are at perfect rest:

If this, I say, be urged against our doctrine, we shall not deny the objection to be plausible, but must not acknowledge it to be unanswerable.

For of the seeming continuity of water and other liquors this may be the reason, that the particles, whereof the liquor consists, being too small to be visible, and being not only voluble, but in actual motion, the pores or vacant spaces intercepted between them must also be too little to be discerned by the eye, and consequently the body must appear an uninterrupted or continued one: not to mention, that, were the parts of the liquor less minute, their shifting of places would hardly be perceived by the eye, each displaced corpuscle being immediately succeeded by another like it. It is true, that a heap of grains of nitre, though upon its effusion out of the vessel it somewhat emulates a fluid body, does yet, when it rests in the vessel, appear to be but an aggregate of many little incoherent bodies heaped up together; because the intervals or holes left between them are great enough to affect the sense: but if the same salt be reduced into an alcohol (as the chymists speak) or impalpable powder, the particles and intercepted spaces being then extremely lessened, the body they make up will much more resemble an intire mass, though it be looked upon from a nearer distance; and so when this powder is by the fire further broken into parts incomparably smaller than those of the powder, and which consequently intercept such extremely little pores, that not only salt-petre, but some metals, and even gold it self, (from which it will not be supposed that any thing exhales to lessen it) are by some affirmed (for I have not my self diligently enough observed it, and do yet doubt it) to take up rather less than more room melted than cold, why should we not grant, that these pores may be little enough, not any where to discontinue the body as to sense?

SECT. XXI.

And that the incoherent parts of fluid bodies are also diversly agitated, some this way, and some that way, though the sense cannot discern it, may be proved by their sensible operations*. For without such local motion, how could the particles of water pierce into the recesses of bodies, and occasion those putrefactive alterations that are wont to be imputed to superfluous moisture? and how comes it else to pass, that aqueous liquors so readily diffuse themselves into, and so exquisitely mingle with one another? as we see when red and white wine are in a trice confounded into claret: and without this various agitation of the parts of water, how could it be, that lumps of sugar or salt cast into it should quickly be so perfectly dissolved in it, that the lumps themselves totally disappear, and the dissociated parts are carried about every way by those of the water, even from the bottom to the very top? As is evident particularly in sea-salt, which when the superfluous liquor is sufficiently exhaled, begins visibly to coagulate, not at the bottom, but upon the surface of the water; and not only salt, but even gold it self, though the heaviest of bodies, may have its parts so scattered by the agitation of those waters, as experience has taught us, and as you may easily try by putting a little of the solution of gold, made in aqua regis, into fifteen or twenty times as much fair water, which will all thereby be immediately ennobled with a golden colour. That the little bodies, whereof flame consists, are fiercely agitated, appears oftentimes even to the eye, and will scarce be denied by him, that considers the operations of it, and the vivid beams it darts round about it against the neighbouring bodies. And that the particles, that compose our common air, are also very diversly agitated, we may be induced to believe by sundry particulars. As first, by those little moats, that from a shady place we see swimming up and down in the sun-beams, and by the tremulous motion, which that of swarms of little bodies in the air seems to impart to distant objects looked on after sun-rise through a good telescope, (and which by the bare eye in hot weather may be often discovered by certain very dilute shades, which seem to tremble upon the walls of high-roofed halls and churches, and other spacious buildings.) Next, (and more easily) by this, that if you take salt of tartar, first brought to fusion, and place it in a cellar, or even in an ordinary room, it will in a short time (now and then in a few minutes) begin to relent, and have its surface softened by the imbibed moisture of the air, wherein if it be left long enough, it will totally be dissolved into clear liquor; which would not be, if the moist vapours that help to constitute the air, did not move to and fro every way, and were not thereby brought to the salt, and enabled to insinuate themselves into its pores, and by that means dissolve it, and reduce it with themselves into a liquor.

And even in summer, when the air is wont to be much dryer than at other seasons of the year, one may quickly discover, that there are in the air store of aqueous corpuscles, moved some one way and some another, by the experiment of putting into a drinking-glass, for want of ice and snow, some beer or wine actually very cold: for thereby, after a while, the outside will appear all bedewed with little drops of liquor; which seems plainly to be no other than the aqueous steams, that swimming up and down in great multitudes in the air, are by its agitation towards all parts carried, as every other way, so to the sides of the glass, and be-

* The author now finding, that something concerning the various motion of the parts of fluid bodies, which he has but touched upon, has been, though but briefly and without experiments, yet excellently explained in a mathematical way by Monsieur *des Cartes* in the 56th and 57th articles of the second part of his principles, thinks fit to refer the inquisitive reader thither for fuller satisfaction about that particular.

ing there condenſed by the coldneſs of that ſmooth body, turn into viſible and palpable water. And, if I much miſ-remember not, it was one of the circumſtances of the laſt experiment of this kind we have had occaſion to take notice of, that the drops, that faſtened themſelves to the outſide of the glaſs, purpoſely left in part unfilled, reached either not at all, or very little further than the ſurface of the liquor within the glaſs, whoſe coldneſs as it ſeems did not infrigidate thoſe upper parts of the glaſs, to whoſe level the liquor it ſelf did not reach. To which I could eaſily add arguments to prove, that the drops we have been ſpeaking of proceeded not from the tranſudation of the liquor within the glaſs, if I thought it worth while to diſprove ſo unlikely a conjecture. But inſtead of that I ſhall only intimate, that from this experiment uſeful hints may be taken both theorical and practical, and particularly, that a reaſon may, perchance, be given of a ſtrange way of catching a ſalt and liquor out of air, barely by glaſs-veſſels of a peculiar and ſkilful contrivance. Much of what we have lately ſaid will, I preſume, be the leſs wondered at, if we ſubjoin what experience has taught us, that it is not difficult by the help of a convenient furnace and fit veſſels to make that ponderous metal, lead, aſcend to a good height in the open air, in the form of a copious ſmoke: ſuch a ſmoke we diſcerned after a while to be carried ſo many ways by the aërial corpuſcles, that it met with in actual motion, that it was ſoon diſperſed ſo far as to diſappear; which perhaps will be thought ſome confirmation of what we formerly delivered, when we taught, how much the being divided into very minute parts may conduce to the fluidity even of ponderous bodies.

SECT XXII.

AND though quickſilver be, excepting gold, the heavieſt known body in the world, yet when it is reduced into vapour, it ſeems to be carried to and fro like the other terreſtrial particles, that ſwim up and down in our air: for I remember, that an expert gilder not long ſince complained to me, that if when he evaporated quickſilver, he forgot to take off his rings from his hand, though they touched not the quickſilver whilſt it was in a body, the roving fumes would oftentimes faſten upon the gold in ſuch plenty, as would put him to much trouble to get them off from his rings; one of which he ſhewed me, that he had lately thus whitened, and as it were ſilvered over with mercurial fumes, and was then to reſtore to its native yellow.

SECT. XXIII.

BUT let us return to viſible liquors, and endeavour to prove almoſt *ad oculum*, as they ſpeak, that their inſenſible parts may be every way agitated, though their motion be but ſeldom viſible to us. Take then what quantity you pleaſe of aqua fortis, and diſſolve in it as much as you pleaſe of ordinary coined ſilver, (it not being neceſſary for this experiment that it be refined) and pour the coloured ſolution into twelve or fifteen times as much fair water, and then decant or filtrate the mixture, that it may be very clear. If you look upon this liquor, the parts of it will ſeem to be all of them as perfectly at reſt as thoſe of common water; nor will your eye be able to diſtinguiſh any corpuſcles of ſilver ſwimming in the liquor: and yet that there are ſuch metalline corpuſcles agitated to and fro with and by thoſe of the water, will quickly appear, if you immerſe into it a flatted piece of clean copper, for by that time you have held it two or three minutes of an hour (perhaps not ſo long) in the liquor, you ſhall ſee the particles of ſilver, that were roving up and down the liquor, faſten themſelves in ſuch ſwarms to the copper-plate, that they will appear in their native hue, and cover it, as it were, with a looſe caſe of ſilver, which may be eaſily ſhaken off in the form of a metalline powder: and if ſeveral ſuch plates be left all night, or for a competent number of hours, in the bottom of the veſſel, you may the next day find all the particles of ſilver, that were diſperſed through the whole body of the liquor, ſettled upon or about them; the deep bluiſh green tincture you will diſcover in the water proceeding only from ſome little parts of the copper-plates, and of the alloy of the coin, diſſolved by the ſaline particles of the aqua fortis. And I remember, that, to compleat the experiment, I have ſometimes made even theſe fall to the bottom of the veſſel, by leaving a lump or two of ſpelter there for two or three days: for, not only thoſe metalline corpuſcles, that were juſt over or near to the determinate place, where I put the ſpelter, but alſo all the reſt, into how remote parts ſoever of the liquor they were diffuſed, did ſettle upon the ſpelter, as appeared both by its increaſe of bulk, and by their leaving the water clear and colourleſs; which plainly ſeems to have proceeded from hence, that the particles of the water were reſtleſly and every way agitated, and ſo by frequently gliding along the ſurface of the ſpelter they muſt carry thither of the corpuſcles of copper mingled with them, ſome at one time and ſome at another, till at length all were brought to it and detained there.

SECT. XXIV.

THAT of the particles of ſpirit of wine, and ſuch like inflammable liquors drawn from fermented juices, though they ſeem to the eye to be at reſt, a good many do yet move confuſedly and very nimbly, I remember I have long ſince manifeſted by an eaſy and ocular proof, which I deviſed about ten or twelve years ago, when (being yet ſcarce more than a boy) I firſt began to conſider what fluidity might be. The experiment, as I writ it down, with all the circumſtances and obſervations relating to it, I have not now by me; but having divers times been deſired to ſhew it to learned men (phyſicians, mathematicians, and others) I cannot have forgotten thoſe phænomena of it, that are the moſt pertinent to our preſent ſubject. Suppoſing then, that in pure ſpirit of wine, beſide the aqueous parts that glide ſoftly along each other, there are ſtore of volatile and ſpirituous

corpuſcles, whoſe agitation is ſtronger, I let fall (from a pretty height, that it might be broken into ſmall drops by its fall) into any wide-mouthed glaſs filled with this liquor, (which muſt not be over dephlegmed, leſt the oil ſink in it) a little common oil or ſpirit of turpentine, which I therefore made choice of, becauſe its tenacity, greater than that of the chymical oils of ſpices, makes it, that it will neither mingle with ſpirit of wine, nor ſpread it ſelf, as divers other diſtilled oils will, upon the ſurface of it, but keep it ſelf in the form of round drops, whoſe ſhape facilitates their motion. The oily drops then ſwimming at the top of the ſpirit of wine, will be, by the diſorderly rovings of the agile parts of it (which hit againſt them little globes, as the vinous ſpirits aſcend to exhale) made to move reſtleſly to and fro in an irregular manner, the drops ſometimes bearing up to one another, as if all or moſt of them were preſently to unite into one body, and then ſuddenly falling off, and continuing to ſhift places with one another, after a manner pleaſant and ſtrange enough to them, that never before ſaw the experiment: and this dance will continue for half an hour or an hour, (or a ſhorter or much longer time, according to the quantity and ſtrength of the liquor) till the ſpirituous parts being flown away, the drops being no longer impelled lie at reſt upon the diſpirited liquor, as they would upon common water. And whereas the nimble motion of the drops might be ſuſpected to proceed from ſome ſecret contrariety in nature betwixt the oil of turpentine and ſpirit of wine; beſides, that I could eaſily ſhew, that thoſe two liquors have no antipathy, I not only tried the experiment with another inflammable liquor than ſpirit of wine, but (if I much miſremember not) found, as I expected, that little pieces of chopped ſtraw (ſuch both being light and not eaſily imbibing moiſture) being gently let fall upon the ſpirit of wine, were in a tumultuous manner carried to and fro upon the ſurface of it; though I am not ſure, but that the motion of the oily drops may be in part due to ſome partial ſolution made of them by the vinous ſpirit, which during that action may tumble them to and fro; not to add, that I have, by ſome trials, been tempted to ſuſpect the air may have ſome intereſt in the motion of the drops. However, I have mentioned the recited experiment, not as if I thought that either it or fugitive ſpirit of wine were fit to teach us the nature of fluid bodies in general, but to ſhew by an ocular example, that there may be a quick and inteſtine motion in ſome parts of a liquor, notwithſtanding that the unaſſiſted eye can diſcern no ſuch matter. I ſhall not here relate, how having cauſed to be hermetically ſealed up ſome of theſe liquors in a glaſs, to try how long the extravagant dance of the drops would laſt, when the more ſpirituous parts of the vinous liquor could not exhale, my veſſel was ſoon broken without any diſcernible violence. Nor ſhall I now take notice of any of the other phænomena of our experiment, partly, becauſe I have elſewhere mentioned moſt of them; and partly, becauſe I think it more pertinent to our preſent theme, to obſerve, that this unſeen agitation of the minute parts will not only hold in light and ſpirituous liquors: for, that the inſenſible parts even of the heavieſt liquors themſelves are alſo in actual motion, though many may think it unfit to be believed, will follow from what has been already delivered concerning the nature of fluid bodies, as ſuch; and may be confirmed by this, that whereas three of the heavieſt liquors, we yet know of, are quickſilver, oil of tartar *per deliquium*, and oil of vitriol; that firſt-named will even in the cold penetrate into the pores of foliated gold, and deſtroy the texture of that cloſeſt of metals: the liquor alſo of ſalt of tartar will in the cold draw tinctures from ſeveral bodies, and we have endeavoured to evince the agitation of the parts of oil of vitriol, not only by ſhewing, how in the cold it would corrode divers metals, but by caſting little pieces of camphire into it, which without the aſſiſtance of the fire were made liquid by it, and appeared like ſo many drops of oil. And he, that yet doubts, whether the parts of theſe two oils (as chymiſts abuſively call them) how ponderous ſoever they be, are fiercely agitated or no, may probably be ſoon ſatisfied by ſhaking an ounce or two of each of them together, and obſerving the heat, hiſſing, ebullition, and ſparkling, that will ſuddenly enſue upon their being blended.

SECT. XXV.

BUT here we muſt take notice, that though it belong to the nature of fluid bodies, that their parts do eaſily ſhift places; yet that is to be underſtood only as to the parts of the ſame fluid bodies, as water, or of ſuch differing fluid bodies as are diſpoſed readily to admit each other's particles, and mingle together, as we ſee in water and wine. For otherwiſe fluid bodies may be of ſuch differing natures, that when two or more of them are put together, they will not mix, but each retain its own diſtinct ſurface; ſo that in regard of one another, the contiguous bodies do in ſome degree emulate each of them the nature of a conſiſtent body: for though it cannot be looked upon as a hard body but a ſoft, becauſe of the eaſy ceſſion of its ſuperficies, yet it does like a compact or conſiſtent body deny to mingle permanently with the contiguous liquor or other fluid ſubſtance. And I ſomewhat wonder, that *Lucretius* and other Atomiſts ſhould (at leaſt for aught I remember) over-ſee this obſervation, ſince it is obvious enough in oil, which will not mix with water, but float upon its ſurface: not to mention, that quickſilver will not incorporate with any of the familiar liquors known to the ancients. I had almoſt forgot, that I promiſed at the beginning of this diſcourſe an inſtance concerning flame, which I will therefore now recite. And it is, that having by an eaſy preparation of copper, by the intervention of a little ſal-armoniac, (which I have already taught in another treatiſe*) ſo opened the body of that metal, as to make it inflammable; I took ſome ſmall grains of this prepared

* An Hiſtorical Dialogue about Flame.

prepared mineral, and put them under the wick of a ſtrong and actually burning candle, whereby (as I expected) they were with the melted tallow ſoon carried up to the bottom of the flame, and by it ſo kindled, that the green (not blue) flame of the cupreous body did (ſomewhat to the wonder of the ſpectators) burn for a good while (this combuſtible matter being marvellouſly laſting) diſtinct from the yellow flame of the candle, as if there had been ſome inviſible partition between them. But to return to the unmingleable liquors we were formerly ſpeaking of; the cauſe, why theſe retain their diſtinct ſurfaces, my preſent taſk does not oblige me to inquire into: but this I ſhall obſerve in general, that it ſeems to depend very much upon the texture of the particular liquors, and perhaps too upon the peculiar motions of their minute parts. For I have obſerved, that though pure ſpirit of wine and ſalt of tartar, reſolved into a liquor by the moiſture of the air, will, when put together, retain diſtinct ſurfaces, or preſently regain them if you ſhake the liquors never ſo ſtrongly together; yet by adding a little fair water to either of them, the texture being thereby altered, it will eaſily incorporate with the other. And thus although that (as I noted already) common ſpirit or oil of turpentine will not mingle with ſpirit of wine, yet having had the curioſity to make a trial with oil of turpentine abſtracted ſkilfully, and with a very gentle fire, (for otherwiſe the experiment may eaſily miſcarry) from melted or at leaſt well decrepitated ſea-ſalt, we found, according to expectation, that though there appeared no viſible alteration in the oil, yet we could eaſily by ſhaking confound it with pure ſpirit of wine. Moreover, though lixiviate liquors and oils will not by an ordinary agitation be permanently joined, yet I have tried, that by digeſting a good while a ſolution of ſalt of tartar with oil of almonds, I could reduce them to a ſoft ſaponary ſubſtance: which experiment makes ſomewhat more to my preſent purpoſe, than the common practice of ſoap-boilers, becauſe I did not, as they, boil away the water wherein the lixiviate ſalt is diſſolved. I might add alſo, that if you put one part of quickſilver into about four parts of oil of vitriol, you will find (at leaſt if the experiment proceed always after the ſame manner as it has done with me) that the two liquors will remain diſtinct whilſt you keep them in the cold, but if by degrees of heat you bring the oil of vitriol to boil, it will pierce the ſurface of the quickſilver, and by partly incorporating with it, reduce it to a ſubſtance very differing from what it was. But becauſe theſe two laſt experiments may be, with leſs improbability than the two that preceded them, referred to other cauſes, I ſhall no farther inſiſt on them, but take notice of one thing more concerning the difference of fluid bodies. And it is this.

SECT. XXVI.

I OBSERVED, that ſome of them do not only not mingle with others, that are contiguous to them, but faſhion the ſurfaces of thoſe others, and reduce them to determinate ſhapes. This I have taken pleaſure to conſider in ſome chymical liquors, which I have purpoſely put together; for inſtance, having poured ſpirit of wine upon oil of tartar *per deliquium*, (as chymiſts call it) I found, that the ſuperficies, wherein they touched each other, was flat, or (as to ſenſe) parallel to the horizon. But if this were done in a very ſlender or narrow glaſs, with the mouth unſtopped, though the lower ſurface of the ſpirit of wine which touched the other liquor appeared very level; yet the upper ſuperficies, which was contiguous to the air, was manifeſtly very concave. And if to theſe two liquors I did in a broader glaſs pour oil of almonds, that oil would ſink to the bottom of the ſpirit of wine, (that being well rectified) and floating upon the oil of tartar, would ſeparate the two liquors, and both above and below retain a flat or level ſurface. But if inſtead of oil of almonds, or another expreſſed oil, I dropped into pure ſpirit of wine, ſwimming upon oil of tartar, ſome common oil of turpentine; the oil would gather into parcels, (ſome of the bigneſs of hail-ſhot, ſome as big as ſmall piſtol-bullets, and ſome of other ſizes) which in caſe they did ſwim in the ſpirit of wine, and touched neither of its ſurfaces, ſeemed globulous, and continued ſo (the glaſſes being ſtopped) for many hours: but in caſe they emerged to the upper part of the ſpirit of wine, as much of them as lay immerſed in the ſpirit (which was by far the greateſt part of them) appeared round, and continued ſo long as I pleaſed; the upper parts only of thoſe little globes appearing to have the ſame ſurface with the ſpirit of wine. And I further obſerved, that ſome ſmall drops would, as it were, reſt conſtantly upon the ſuperficies of the oil of tartar, touching it but as it were in a point, and continuing to the eye ſpherical; though the ſurface of the liquor were purpoſely now and then ſomewhat ſhaken. But that, which I took ſpecial notice of, was, that having (upon deſign) into pure ſpirit of wine (for upon common ſpirit oil will ſwim) let fall ſome great drops of oil of turpentine, they did at firſt ſink to the bottom of it, and lie upon the ſurface of the oil of tartar almoſt like hemiſpheres, whoſe convex part was all above the oil of tartar; but after a while they were, as I expected, preſſed on all ſides and faſhioned into round bodies (yet a little more protuberant at the ſides than the top) which ſeemed ſcarce to touch the ſurface of the oil of tartar on which they leaned. Divers other obſervations of this kind were afforded me by ſome peculiar mixtures, that I made of chymical liquors: but not having the leiſure to ſet them down, much leſs to inquire into their cauſes, I ſhould ſcarce have mentioned what I have already delivered (eſpecially ſince we found that a light variation of circumſtances would often alter the event of ſuch trials, which we have therefore ſet down barely hiſtorically) but that finding that drops of water, quickſilver, and other fluid bodies, ſeemed to be faſhioned into a round figure by that every way almoſt equal preſſure of the ambient air; and having likewiſe tried, that quickſilver ſuſpended

in

in the air (as it may eaſily be, if the Torricellian experiment being made in a tube exceeding ſlender, ſome air be afterwards dexterouſly let in to divide the long mercurial cylinder into diverſe ſhort ones) has both at the top and bottom, where it is expoſed to the action of the air, a very protuberant ſurface; finding, I ſay, theſe effects of fluid bodies upon one another, I thought it not amiſs to intimate, how ſome experiments might be made, that may poſſibly facilitate the giving an account of the figuration of ſome of the more conſiderable fluid bodies, which, as we noted already, make up much the greater part of the univerſe: eſpecially, ſince I could eaſily enough make it probable, that ſuch ſteams of the terreſtrial globe, as may well be ſuppoſed to be the chief ingredients of our atmoſphere, may like a liquor retain a ſuperficies diſtinct from that of the ambient and contiguous body. And ſince we are ſpeaking of the diſtinct ſurface of fluids, the occaſion invites me to add an experiment, which, though apt to miſcarry upon the account of unheeded circumſtances, has yet, when all things were rightly ordered, ſucceeded very well: I will, I ſay, ſubjoin it here, becauſe it ſhews a way of dividing in a trice a liquor tranſparent, and, as to ſenſe, homogeneous, into two very differing liquors, the one diaphanous, and the other opacous, which will not mingle. The experiment is this. Diſſolve one ounce of clean common quickſilver in about two ounces of pure aqua fortis, ſo that the ſolution be clear and total; then whilſt it is yet warm, pour into it by degrees, leſt they boil over, half an ounce or one ounce of filings of lead, and if no error, nor ill accident have intervened, the lead will be in a trice precipitated into a white powder, and the mercury reduced into a maſs (if I may ſo ſpeak) of running quickſilver, over which the remaining part of the aqua fortis will ſwim, whereby we may ſee, that liquors being reduced into very minute parts, may mingle very well, the corpuſcles of the one ſupporting in that ſtate thoſe of the other, though in greater bulk; eſpecially, the texture of one being ſomewhat varied, they will retain diſtinct ſurfaces. *N.B.* Note, that when the operation ſucceeds not well, the mercury need not, for all that, be loſt, but may (in great part at leaſt) be recovered by freeing the precipitated matter from the reſt by filtration, and then diligently grinding the white precipitate with water, by which means, the mercury will little by little be gathered into drops. And though this be far from being the true mercury of lead, as I may elſewhere ſhew you; yet ſome inducements, not here to be named, incline me to look upon it, as ſomewhat differing from common mercury, and fitter than it for certain chymical uſes.

SECT. XXVII.

AND here I ſhould paſs on to the conſideration of firmneſs, but that, when a while ago I diſcourſed of the agitation of the corpuſcles that compoſe oil of tartar and oil of vitriol, I forgot to add, that not only in fluid bodies, but in ſome alſo of thoſe that are conſiſtent, there may perhaps be more motion in the inſenſible parts than our ſenſes diſcern, or we are wont to imagine; eſpecially in thoſe bodies, which having been once endowed with life, are, though not fluid, yet either ſoft, or at leaſt not perfectly hard. I have more than once taken pleaſure to look upon an heap of ſwarming bees, for though they make not up a liquid but coherent body, which may be turned upſide down without loſing its coherence, and which being beheld at a diſtance, ſeems to be one entire maſs or body; yet it is evident to him, that looks at them near enough, that the particular bees, that ſwarm, have moſt of them their diſtinct and peculiar motions, and that yet theſe motions of the particular bees deſtroy not the coherency of the heap; becauſe that when one of the more innermoſt bees removes, as ſhe lets go her hold from thoſe, that ſhe reſted on before, and goes away from thoſe that reſted on her, ſo ſhe meets with others, on which ſhe may ſet her feet, and comes under others, that in like manner ſet their feet on her; and ſo by this viciſſitude of mutual ſupports their coherence and their removes are made compatible. And if inſtead of bees, the ſwarm conſiſted of extremely little flies, their particular motions would perhaps be inconſpicuous. And that ſome ſuch thing may happen in the conſiſtent bodies we have been ſpeaking of, ſeems probable from hence, that in wainſcot and other hard wood, we often ſee little heaps of duſt produced in them by putrefaction; and not only in cheeſe we many times ſee multitudes of mites ſtart up, but in apples and other fruits we oftentimes find maggots, though the ſkin be whole, (which could not be unleſs the parts of the matter were variouſly tranſpoſed, that is, put into a local motion, and connected after a manner ſuitable to the nature of the inſect to be produced.) And by the growth of bones in the bodies of perfecter animals, as well in reſpect of the internal cavity, where the marrow lodges, as of the external ſurface, as alſo by the growth of the ſhells of oyſters and ſnails, (though cold animals) from a ſize inconſiderable at firſt, in regard of what is afterwards attained to, and by ſome other reſembling particulars, it ſeems, that the ſmall particles, that conſtitute even the ſolid parts of animals, are not, whilſt the creature lives, (or at leaſt whilſt it grows) altogether exempt from ſome (though ſlow and inſenſible) local motion. And I remember, that it has by a very diligent obſerver been affirmed to me, that he ſaw ſeveral pieces of gum ſweat out of an old wainſcot of above twenty years ſtanding. Which I the leſs wonder at, becauſe I have ſeveral times ſeen viſcous exſudations diſcloſe themſelves like drops of turpentine upon deal-boards, which had been made uſe of about building. (But of this ſubject more, perhaps, elſewhere.)

SECT. XXVIII.

AFTER we have hitherto diſcourſed of fluidity, as conſidered in diſtinct bodies, we might properly enough ſay here ſomething of what furtherance or hinderance, in reſpect of fluidity, one body may receive by being mingled with another.

another. But the conſideration of thoſe changes of conſiſtence, which may be produced by mixture, is a ſubject; that we ſhall have ſuch frequent occaſions to treat of in what we are to deliver about firmneſs, that we ſhall now only give this general admonition, that it is not ſo ſafe as one would think, to foretel the conſiſtence of a mixture of two or more bodies, from the bare conſideration of the conſiſtence of thoſe bodies, whereof it is to be compounded. And that we might at once both manifeſt this, and inſinuate what judgment ſhould be made of what is ſaid by ſo many chymiſts and others, who without limitation teach, that the addition of ſalts to metalline and mineral bodies does much facilitate their fuſion, I remember I purpoſely made and employed this experiment.

WE diſſolved crude copper in a due quantity of ſpirit of nitre, and by evaporation reduced the ſolution to a kind of vitriol of a lovely colour. We alſo corroded with two parts of ſpirit of nitre one of good tin, and ſuffered the mixture to reduce itſelf (as it eaſily did) to a ſubſtance almoſt like meal. Of this mixture we put a parcel into a crucible, and ſuffered it to grow (and for a pretty while to continue) red hot: nay, we put ſome of it upon a quick coal, and excited the heat by frequently blowing the fire, without finding, that this metalline meal did at all melt, though ſalt-petre be a fuſible ſalt, and tin it ſelf be of exceeding eaſy fuſion. Whereas, although copper be a metal, which is much harder to melt, not only than tin and lead, but even than ſilver, (as thoſe well know, that mix ſilver with copper to make a fuſible mixture to ſolder upon copper and braſs) yet was this metal, that will endure a long and ſtrong ignition by being joined *per minima* with the ſame kind of nitrous corpuſcles, that had ſo contrary an effect upon the tin, ſo ſtrangely diſpoſed to fuſion, that the vitriol would melt with as ſmall a heat as that of one's hand. Nay, we have made ſuch a vitriol either with ſpirit of nitre or with (what differed little from it) a certain aqua fortis, as would even in winter be made to ſtand melted for divers hours together, by the languid warmth of the ſun, though ſhining on it but through a window, where it alſo ſtood but in an unſtopped glaſs. So fit it is, that we conſider as well the new texture, that mingled bodies obtain by the aſſociation of their particles, (whoſe ſize and ſhape, and perhaps motion may be thereby much altered) as the conſiſtence of the particular bodies before their being mixed.

THE

Hiſtory of FLUIDITY and FIRMNESS.

The Second Part.

Of FIRMNESS.

IT is ſufficiently known, that the chymiſts aſcribe the firmneſs and hardneſs of bodies to ſalt, and teach, that the ſaline ingredient of them is the principle of coagulation in them, and the cauſe of their compactneſs and ſolidity. But though this opinion of the chymiſts be embraced by ſo many modern philoſophers and phyſicians, that ſome may think it ſuperfluous to make enquiry after other cauſes; yet others (to whom the explications of chymiſts ſeem not always ſo much as intelligible) will, upon the very account of the receivedneſs of the propoſed opinion, think it rather worthy to be examined, than to be acquieſced in. However, without making it our buſineſs, either to ſide with, or oppoſe any ſect of naturaliſts, we will apply our ſelves a while to conſider the thing it ſelf in proſecution of the deſign already begun. And having in the fore-going part of our little hiſtory taken a general view of fluidity; we will now proceed to try, what light it will afford us to diſcover the nature of firmneſs or compactneſs.

AND ſince fluidneſs and ſtability being contrary qualities, are to be apprehended under contrary notions, we may conceive, that the firmneſs or ſtability of a body conſiſts principally in this, that the particles, that compoſe it, beſides that they are moſt commonly ſomewhat groſs, either do ſo reſt, or are ſo intangled between themſelves, that there is among them a mutual coheſion, whereby they are rendered unapt to flow or diffuſe themſelves every way, and conſequently to be, without violence, bounded and figured by other ſurfaces than thoſe, which their connection makes themſelves conſtitute.

IN this rude deſcription of firmneſs we have intimated three principal cauſes of it, namely the groſſneſs, the quiet contact, and the implication of the component parts.

THE firſt is groſſneſs of parts, of which we have in effect almoſt ſufficiently diſcourſed already: for ſince treating of fluidity, we manifeſted at large, how conducive ſmallneſs of parts was to that quality; it is eaſy to deduce, that groſſneſs of parts in a body muſt commonly be a great diſpoſition to its being firm. And bigger corpuſcles being *cæteris paribus* more difficult than leſſer to be put into motion, when they are once at reſt, it is obvious, that a body conſiſting of ſuch particles is leſs diſpoſed to become fluid, and conſequently more apt to continue firm, than if its component parts were ſmaller, and thereby more eaſy to be diſplaced. But when I ſpeak of the groſſneſs of corpuſcles, I pretend not to determine, whether or no body or matter be ſo perpetually diviſible,

ſible, that there is no aſſignable portion of matter ſo minute, that it may not at leaſt mentally (to borrow a ſchool-term) be further divided into ſtill leſſer and leſſer parts: for allowing this indefinite diviſibility of corporeal ſubſtance, it is plain, that it may in ſome ſenſe be averred, that there are no firm bodies, whoſe parts are not extremely minute. But I underſtand by the groſs parts I here ſpeak of, ſuch corpuſcles, as actually convening to conſtitute a body, are ſcarce diſſipable or diviſible into leſſer by the agitation of the ambient air or æther, or by the other cauſes of the fluidity of bodies.

IT is alſo to be noted, that when I ſpake of the fitneſs of groſſer corpuſcles to make a firm body, I added, *cæteris paribus*, becauſe it may happen, that the breaking of the ſmall parts of a body into minute particles may make them but the fitter to contribute to the firmneſs of the body they belong to: for the parts of the divided corpuſcles may by their comminution acquire a new, and perhaps a more irregular ſhape than before, upon whoſe account they may be more diſpoſed to be entangled among the neighbouring particles, or may be better fitted to get into and fill the pores of ſome kind of bodies. And in ſuch little particles, not only the minuteneſs may make them lie cloſer together, and conſequently the better exclude the air; but the greatneſs of the ſurface in proportion to the bulk of the matter may perhaps in ſome caſes occaſion a fuller contact, and ſo facilitate the conſtitution of a very firm body, in caſe theſe minute parts (whoſe intervals, if they intercept any, need not be other than very ſmall) ſhall be placed and diſpoſed to the beſt advantage for a full contact of one another. But as I ſaid a while before, from what we have already delivered (concerning the ſize of parts, when we treated of fluidity) it may eaſily be underſtood, how much the magnitude of them may conduce to firmneſs; and therefore we will preſently paſs on to the mention of the two other things to be conſidered, in reference to conſiſtent bodies. Whereof the one is the bare reſt of the ſmall and contiguous parts, that make up the firm body; and the other the intricate texture of ſuch parts in the body they make up. And either of theſe two ſeems alone ſufficient to render a body ſtable; though nature do perhaps oftentimes make ſome (though not equal) uſe of both, to faſten the parts of the ſame body more firmly together.

OF the former of theſe cauſes, I am informed, that the juſtly famous Monſieur *Des Cartes* has alſo taken notice, but without adding proof from experiments, or obſervations. But it ſeems to have been either over-looked, or, (as incongruous to their hypotheſis of the innate motion of atoms) rejected by the old atomiſts, and by *Lucretius*, who takes notice (that I remember) only of the latter: for though they did of old make mention of the ſudden divulſion of two flat and ſolid bodies, yet they employ that obſervation but to prove a vacuum, (without otherwiſe taking notice, that I have met with, of thoſe things, that are moſt material in ſuch obſervations to our preſent purpoſe, and without deducing thence what we ſhall endeavour to do in order to the explication of the cauſes of firmneſs.) Upon what account then ſoever the atomiſts have omitted to reckon for a cauſe of firmneſs that, which we have newly been ſpeaking of; yet (as we obſerved above) if two bodies be once at reſt againſt one another, it ſeems conſonant to the catholick laws of nature, that they ſhould continue in that ſtate of reſt, till, ſome force capable to over-power their reſiſtance puts them out of it. And whatever may be ſaid of the unloſable mobility of atoms ſtrictly ſo taken, yet that divers parts of matter may compoſe bodies, that need no other cement to unite them, than the juxta-poſition which we here pre-ſuppoſe, and the reſting together of their parts, whereby the air and other fluid bodies, that might diſſociate them are excluded, I have been inclined to think by what I have obſerved in grinding of glaſſes: for ſometimes the convex ſurface of one body being ground upon the concave ſurface of another, the two ſurfaces will happen to be ſo cloſely and exactly fitted to one another, (their immediate contact in all their parts, or at leaſt in innumerable of them, hindering the intercurrence of the air) that a man is not able without breaking one or both of them to pull them directly aſunder; but if you will ſever them, you muſt be fain to make one of them to ſlip along the ſurface of the other: which makes the glaſs-grinders often complain of the trouble they meet with in ſeparating ſuch bodies. Nay, if you lay two flat glaſſes ground very true and well poliſhed upon one another, ſo that their ſurfaces may almoſt every where touch each other, (to which it will be requiſite to rub them a little one upon another, for the better excluſion of the air) you may by lifting up the uppermoſt, lift up the lowermoſt (though perhaps, as we have often tried, two or three times bigger) with it, as if the two plates of glaſs made but one body. Nay, we have divers times taken up four or five pieces of glaſs at once, laid and preſſed thus one upon another, and might, perchance, have taken up a greater number, if we had had more of them at hand. And trial has alſo informed us, that if you hold a looking-glaſs very level with the unfoliated ſide downward, and rub a little againſt it a piece of other very flat and very ſmooth glaſs, you may eaſily, by that way only, faſten them to one another; ſo that the lowermoſt glaſs, though large, will hang between the uppermoſt and the ground, to the wonder of thoſe, that behold it, and can diſcern nor imagine nothing capable to keep it from falling: and by the ſame way (as we ſhall recite anon) we have often made one conſiderably thick piece of marble take and hold up another, having purpoſely cauſed their flat ſurfaces to be carefully ground and poliſhed, without which the experiment will not ſucceed. Nor is it requiſite, that the glaſſes be flat to make them adhere very cloſely together, provided their immediate contact be made according to a large ſurface: for to what we have already mentioned concerning the cohering of convex and concave bodies, we may add, that having purpoſely

poſely applied a long glaſs-ſtopple of an almoſt conical figure, and well ground, to the mouth of a thick quart bottle, whoſe neck was made long, and of a figure convenient to receive the ſtopple, and ground within fit for it, we found, that theſe two glaſs bodies touching one another in a multitude of parts, did adhere together ſo cloſely, that when the ſtopple was carefully put in, we could eaſily, and divers times one after another, lift up the bottle, though there was by our gueſs above a pound of liquor in it. Unleſs we ſuppoſe, without much probability, that becauſe it is found, that moving them to and fro upon one another, and preſſing down the ſtopple, promotes their ſticking, their adheſion may be in part aſcribed, either to ſome elaſtical motion in the parts of the preſſed glaſs, or to the exquiſite adaptation of the almoſt numberleſs, though very ſmall, aſperities of the one, to the as numerous little cavities of the other; whereby the ſurfaces do lock in with one another, or are as it were claſped together. For as poliſhed as the ſurfaces may appear to ſenſe, we muſt not deny, that there may be ſuch inequalities in them, ſince being wont to be poliſhed with putty or ſome ſuch powder, or heap of grating and irregularly ſhaped corpuſcles, they muſt needs make ſtore of little furrows, and ridges, and other aſperities on them. But to inſiſt on theſe conjectures, were to digreſs.

YET here we muſt not decline taking notice, that, at leaſt here below, the ſticking together of ſuch bodies, as are of ſenſible bulk, and whoſe ſmooth ſurfaces immediately touch one another, may poſſibly not ſo much proceed from this, that their parts, as we formerly obſerved, are at reſt among themſelves, and by their immediate contact do make up as it were but one body; as from the preſſure of the atmoſphere, proceeding partly from the weight of the ambient air, (mixed with the effluviums of the terreſtrial globe) and partly from a kind of ſpring, by virtue of which the air continually preſſes upon the bodies contiguous to it, though through accuſtomance and negligence, and perhaps ſome other cauſes not here to be inſiſted on, we neither feel it in our own bodies, nor take notice of it in others. Now this preſſure of the air every way being ſuppoſed, I think the adhering of the ſmooth bodies we ſpeak of (for we ſuppoſe them far greater than the particles of the air) to one another may probably enough be aſcribed to this, that when, for inſtance, the ſmooth ſurfaces of two pieces of glaſs do ſo exquiſitely touch one another, that none of the ambient air is either intercepted or admitted between them, then the undermoſt glaſs will ſuffer no preſſure on that ſide, which touches the uppermoſt; the parts of the uppermoſt glaſs having no ſenſible ſpring in them (ſo that they can only reſiſt, but not repel the other:) but that ſide of the undermoſt glaſs, which is expoſed to the air, will be preſſed upon thereby; and there being, as we ſaid, no elaſtical preſſure on the other ſide of the glaſs to balance this, it is not to be wondered at, that the inferiour glaſs ſhould not fall off from the other, in regard the weight, that would carry it downwards, is much too ſmall to overcome that force of the air, that thruſts it againſt the uppermoſt glaſs: as if one ſhould with his hand thruſt a plate of iron broad-wiſe againſt the flat cieling of his chamber, the iron would not fall as long as the force of the hand perſeveres to preſs againſt it. Nor is it material, that in our caſe the preſſure of the atmoſphere is ſuppoſed to force the lowermoſt glaſs upwards; for if we ſuppoſe the air to conſiſt of innumerable little ſprings (as it were) bearing upon and ſupporting one another, and whereof the lowermoſt are bent by the weight of all that are incumbent on them, it will be eaſy to conceive, that near the ſurface of the earth, (about which the air muſt diffuſe it ſelf by reaſon of the gravity of its ſmall parts, and the reſiſtance of the earth againſt their deſcent) it may preſs almoſt equally every way, and by a kind of recoil (though not properly ſo called) from the terreſtrial globe upwards, may ſtrongly preſs any body, upon which it can bear, againſt any other, which has no ſuch elaſtical power to repel from it a body ſo preſſed againſt it.

THIS difficulty being thus diſpatched, we ſhall proceed by two or three particulars, to confirm our conjecture at the cauſe, why ſmooth bodies ſtick together upon bare juxta-poſition or contact. And firſt I obſerve, that if a piece of flat glaſs be, as we formerly mentioned, appended to a looking-glaſs held with the unfoliated ſide downwards, parallel to the horizon, though the adhering glaſs will not drop down, yet it will very eaſily be moved any way along the level ſurface; and if by inclining the looking-glaſs any way, you deprive it of its former level, the ſmaller glaſs will eaſily ſlide downwards upon the ſurface of the greater. Of which the reaſon ſeems to be, partly that the gravity as ſuch of the lower glaſs does not conſiderably reſiſt the horizontal motion of it, but only the motion upwards, whereby it muſt recede from the centre of heavy bodies, as might, if need were, be probably deduced from divers inſtances obvious enough; and partly, or rather chiefly, that to the edges of the glaſs the ambient air is contiguous as well on the one ſide as on the other, and ſo the preſſure of the air being equal on every part of the edges, the gravity of the ſmaller glaſs is not hindered by the air (which can as faſt ſucceed on one ſide, as it is diſplaced on the other) from making it ſlide down the ſhelving ſurface of the greater glaſs; whereas of the broad and flat ſides of the lowermoſt glaſs the one is, as we ſaid, preſſed by the ſpring of the air, whilſt the other ſuffers no ſuch preſſure from the looking-glaſs, to which it was applied. And ſo, if you take a ſmall open-mouthed glaſs, and plunge it into a veſſel full of quickſilver with the mouth upward, that the quickſilver may fill it without leaving any air in it, and if then, whilſt it is under the quickſilver, you turn the mouth downwards, and ſo keeping it upright, lift it up till the mouth be almoſt come to the top of the mercury you ſhall perceive, that the glaſs will remain almoſt full of

quickſilver in the veſſel: and this will continue ſo, though you incline the glaſs this way or that way, provided you keep the mouth of it within the mercury. And this experiment, though more noble when tried with quickſilver, will ſucceed alſo when tried, as it may more eaſily be, with water. Of which the reaſon ſeems to be, that the glaſs hinders the quickſilver in it from the preſſure of the incumbent air, whereas the quickſilver in the veſſel being expoſed to it, muſt by it neceſſarily be forced up againſt the ſurface of the inverted bottom of the glaſs, where it meets no elaſtical power to repel it downwards. For, that it is not nature's abhorrency of a vacuum, that keeps the quickſilver from deſcending till ſome air can come to ſucceed in its room, the famous experiment invented by *Torricellius*, and found true by many others, and our ſelves, touching the deſcent of quickſilver in any tube of above two foot and a half long, ſeems clearly to evince. And to confirm what we have ſaid, and ſhew withall, that it is not ſo much the contact of bodies according to a large ſurface, as that contact is conſidered in it ſelf, as by reaſon of its being ordinarily requiſite to the excluſion of air, that at leaſt here below keeps bodies from falling aſunder; I ſhall relate, that having by a certain artifice out of a large glaſs (with a narrow mouth) cauſed a certain quantity of air to be ſucked, we found, that by immediately applying a book (which then chanced to lie at hand) to the orifice of the veſſel, the book was readily lifted up and ſuſtained in the air as long as we pleaſed, though the ſurface of the ſuſpended body could be touched, as is evident, but by the ring, which incircled the orifice of the veſſel, and though the weight taken up (beſides that it was inconveniently ſhaped for ſuch a trial, which would probably have ſucceeded as well with a much greater weight, if we had had one fitly ſhaped at hand) exceeded twenty ounces *. Of which event the cauſe ſeems plainly to be this, that by reaſon of the exſuction of ſome air out of the glaſs, the elaſtical power of the remaining air was very much debilitated in compariſon of the unweakened preſſure of the external air, which being able to preſs the book againſt the orifice of the veſſel with greater ſtrength than the internal air can reſiſt, thereby it comes to paſs, that the whole orifice of the veſſel, though there be but part of it of ſolid body, does yet on this occaſion perform in ſome meaſure the part of an entire ſurface exactly ſmooth.

IT may be conſidered alſo (to add that upon the bye) whether upon the principle lately explicated may not in ſome meaſure depend the ſolidity of glaſs. For though its parts ſeem very little or not at all branched or interwoven one within another, and appear very ſmooth and ſlippery, yet ſince the fire, that brought them to fuſion, and conſequently to be fluid, may well be ſuppoſed to have ſub-divided and reduced them into very ſmall particles, and to have thereby aſſiſted them to exclude the air from betwixt them, it may ſeem, that it needs not much be wondered at, if the immediate contact of ſuch ſmall and ſmooth corpuſcles ſuffice to make them hold together; for that their union is ſtrict enough to keep out the air, may appear from this, that thoſe that blow glaſſes, and thoſe that diſtil in them, find not the air can traverſe the pores even of heated glaſs: and as for any more ſubtil matter, we ſee by the free paſſage of light and heat, or, to ſpeak more warily, of magnetical effluvia through glaſs, without injuring its texture, that ſuch matter, but moderately moved, will not hinder the little ſolid parts from cleaving together. And on this occaſion it might be conſidered, how much the juxta-poſition of their corpuſcles crouded together by fuſion may contribute to the conſiſtence and brittleneſs of ſalt-petre, and divers other bodies, which may from an incoherent powder be readily turned into one maſs; as alſo how far the ſticking together (for I ſpeak not of the figures compoſed by them) of the ſmall parts of hanging drops of water, and ſuch other liquors, as are not thought to conſiſt of corpuſcles hooked or branched, may be aſcribed to the contact of their ſmall parts, and the excluſion of air. Theſe, I ſay, and ſome other ſuch things might be here conſidered, but that we are forbidden to examine them particularly, and eſpecially what has been repreſented touching the ſolidity of glaſs, (which we ſuſpect another cauſe may have a great intereſt in) by our haſte, which calls us to the remaining part of our diſcourſe.

THOUGH then it be hence (to omit other proofs elſewhere mentioned) ſufficiently manifeſt, that the air has a ſpring, and that a ſtrong one, yet there appears no great neceſſity of having recourſe to it for the giving an account why the two ſmooth glaſſes above mentioned were able to adhere ſo cloſely to each other: for a probable reaſon of the ſame phænomenon may be rendered by the preſſure of the air conſidered as a weight. And firſt, we muſt recall to mind what we (a little above) ſaid of the recoiling (or rebounding of the preſſure) of a cylinder of air from the earth, to the ſuſpended piece of glaſs, proceeding from this, that the fluid air, which is not without ſome gravity, being hindered by the reſiſting ſurface of the terreſtrial globe to fall lower, muſt diffuſe it ſelf, and conſequently preſs as well upwards as any other way. Next, we may conſider, that when the ſurfaces of two flat bodies of any notable (and, for example, of equal) breadth do immediately touch each other, and lie both of them level with the horizon, and one of them directly over the other; in this caſe, I ſay, ſince the air cannot move in an inſtant from the edges to the middle of the two ſurfaces that lie upon each other, the lowermoſt cannot be drawn away downwards in a perpendicular line from the uppermoſt, but that by reaſon of the ſtiffneſs and contact of the two bodies, it muſt neceſſarily happen, that at the inſtant of their ſeparation, ſhould it be effected, the lowermoſt glaſs

* Much more conſiderable inſtances of this nature may be met with in the author's *New Phyſico-Mechanical Experiments*.

will be preſſed upon by the whole (crooked) pillar of air, ſuppoſed to reach from the top of the atmoſphere, and to have for baſis the ſuperficies of the undermoſt glaſs. For at that inſtant, the air having not time to get in between the two glaſſes, there is nothing between them during that inſtant to reſiſt the preſſure of that air, which bears againſt the lower ſuperficies of that undermoſt glaſs, and conſequently ſuch a revulſion of the lower glaſs cannot be effected, but by a weight or force capable to ſurmount the power of the weight of the above-mentioned cylinder of the atmoſphere; and this, as I ſaid, becauſe that by reaſon of the ſudden ſeparation, the upper ſurface of the glaſs has not any air contiguous to it, which, were it there, would (according to the nature of fluid and ſpringy bodies) preſs as much againſt the upper ſurface of the glaſs, as the pillar of the atmoſphere againſt the lower, and conſequently ſuſtain that endeavour of the air againſt the lower ſide of the glaſs, which in our propoſed caſe muſt be ſurmounted by the weight or force employed to draw down the lower glaſs. And hence we may underſtand (to add that upon the bye,) that it is not neceſſary, that the contiguous ſurfaces of the two flat glaſſes, we have been treating of, be paralleled to the horizon: for if you ſhould hold them perpendicular to it, their divulſion would not ceaſe to be difficult, provided it were attempted to be made by ſuddenly pulling one of the broad ſurfaces from the other in a level line, and not by making one of the ſurfaces ſlide upon the other; for in the former caſe, the ſeparation of the contiguous bodies will be hindered by the weight or preſſure of the lateral air (if I may ſo ſpeak) that bears againſt the broad ſides of the glaſſes contiguous to it. But whereas in theſe caſes we ſuppoſe the ſuperficies of the two glaſſes to be ſo exactly flat and ſmooth, that no air at all can come between them; experience has informed us, that it is extremely difficult, if at all poſſible, to procure from our ordinary tradeſmen either glaſſes or marbles, ſo much as approaching ſuch an exquiſiteneſs: for we could very hardly get either experienced ſtone-cutters, or perſons ſkilled at grinding of glaſſes, to make us a pair of round marbles, though of an inch or two only in diameter, that would for ſo much as two or three minutes hold up one another in the air by contact, though they would eaſily enough take up each other, if the uppermoſt were drawn up nimbly, before the air could have leiſure to inſinuate it ſelf betwixt them.

BUT this notwithſtanding, we endeavoured by the following expedient, not only to manifeſt, that the power or preſſure of the air is in theſe experiments very great, but alſo to make ſome eſtimate (though but an imperfect one) how great that power is.

HAVING then provided a pair of marbles of an inch and half in diameter, and as flat and ſmooth as we could get, and having conſidered, that as it was the getting in of the air between them, that (for the reaſon above declared) hindered them from ſticking ſtrongly together; ſo the acceſs afforded to the air was for the moſt part due to that ſcarcely evitable roughneſs or inequality of their ſurfaces that remained in ſpite of the poliſh: conſidering theſe things, I ſay, we ſuppoſed, that the intruſion of the air might be for ſome while prevented by wetting the ſurfaces to be joined with pure ſpirit of wine; and that yet this liquor, that ſeems the freeſt that we know of from tenacity, would not otherwiſe than by keeping out the air prove a cement to faſten the ſtones together. But becauſe the eaſy ſeparation of ſuch ſmooth bodies, as adhere but by contact does in great part (as we formerly noted) proceeds from this, that whereas it is very difficult to hold ſuch bodies exactly level for any conſiderable ſpace of time, and yet the leaſt inclination any way gives the lower body opportunity to ſlide off; becauſe of this, I ſay, we reſolved in the firſt place to ſee what could be done by faſtening to the upper marble certain wires and a button, in ſuch manner, as that the lower marble, when it was joined, might freely fall directly down, but not ſlip much aſide, being hindered by the wire. And in purſuit of this we found, that not only the dry marbles could be made to take up and hold up one another, but that once by drawing up the upper marble nimbly, we could take up (but not keep up for any time) together with the lower marble, a ſcale, and in it a pound weight of 16 ounces Troy.

AFTER this we moiſtened the ſurfaces of the marbles with ſuch pure alkalizate ſpirit of wine, as we elſewhere teach to make, which was ſo thin and ſubtile, that not only we burned ſome of it, before we would employ it about this experiment, in a ſilver ſpoon, without leaving ſo much as any ſign of phlegm behind; but it would (in the open air) almoſt in a moment fly away from the ſurface of the marble anointed with it, and leave it dry and gloſſy. The marbles being ſkilfully wetted, and kept by the above-mentioned wires from ſlipping aſide, we caſt into the ſcale faſtened to the lower of them divers weights at ſeveral times, and by nimbly pulling up the higher ſtone, tried many times, how much we could draw up with the lower, and did ſometimes take up above an hundred ounces, and once an hundred thirty-two ounces Troy, beſides the ſcale, that contained them, and the marble it ſelf, the diameter of whoſe ſmooth ſurface was by meaſure but about an inch and two thirds.

BUT here I muſt take notice, both in relation to this and the following experiments to be ſet down concerning ſmooth marbles, that we never yet found any ſort of experiments, wherein ſuch ſlight variations of circumſtances could ſo much defeat our endeavours; which we therefore mention, that in caſe ſuch experiments be tried again, it may be thought the leſs ſtrange, if others be not able to do as much at the firſt and ſecond, or perhaps the tenth or twentieth trial, as we did after much practice had made us expert in this nice experiment, and ſuggeſted to us divers facilitating circumſtances, which could not here in few words be particularly ſet down.

AND now, becauſe we perceived, that the

ſpirit

ſpirit of wine was too fugitive and ſubtile a liquor for our purpoſe, we ſuppoſed, that oil, as it would better fill up the little cavities of the ſtones, ſo it would more exactly keep out the air, and leſs eaſily vaniſh into it. And accordingly, having moiſtened the ſurfaces with a due proportion of good expreſſed oil of ſweet almonds, and having carefully obſerved the other requiſite circumſtances, we took up ſome drams above four hundred ounces Troy hanging at the lower marble.

AND that you may not ſuſpect, that it was by gluing the marbles together, that the oil did enable them to make ſo much greater reſiſtance againſt ſeparation than the ſpirit of wine did; I ſhall add, that in caſe the flat ſurfaces of the joined ſtones were held not parallel, but perpendicular to the horizon, that ſo the air might (as we formerly alſo obſerved) immediately ſucceed, as the looſer marble ſhould ſlide off, the weight of ſome ounces was now and then requiſite to draw down the marbles, when they had nothing but ſpirit of wine between them; whereas they would eaſily enough ſlide off from one another, when they were cemented together with oil: perhaps becauſe that the ſpirit of wine, by reaſon of the ſmallneſs and penetrancy of its parts, and becauſe of its fugitive nature, did not ſo well fill up the little pores and furrows of the ſurfaces of the marbles; whereby the little protuberances getting into thoſe little cavities, might more reſiſt the ſliding of the marbles upon one another's ſurfaces, whoſe texture is better fitted to make their ſurfaces ſmooth and ſlippery.

AND to ſhew, that the reſiſtance of ſuch contiguous marbles to a violent ſeparation is greater in thoſe, which being broader are preſſed againſt or reſiſted by a proportionably bigger (though not a longer) pillar of the atmoſphere; we cauſed two marbles to be made, whoſe diameter was three inches, or a very little more: and having after the above-mentioned manner employed ſpirit of wine to keep out the air from between them, we did after ſome trials, with the uppermoſt of them take up the lowermoſt, and with it four hundred ſixty eight, or four hundred and ſeventy ounces. But making uſe of oil of almonds inſtead of ſpirit of wine, we did with our own hands draw up twice, one time after another, with the undermoſt ſtone, a much greater weight, namely, eighty-four pound or 1344 ounces (Troy weight) notwithſtanding which weight we manifeſtly perceived the marble, at which it hung, to ſtick ſtrongly to the other.

AND here again we will take notice, that the interpoſed oil was ſo far from being able as a cement, rather than by keeping out the air, to make theſe marbles ſtick ſo cloſe together, that, whereas bodies glued or cemented together are wont to make an almoſt equal reſiſtance to their being ſeparated, in what poſture ſoever you place them, I made our marbles, even when we tried this laſt experiment, very freely ſlide upon one another, by impelling the uppermoſt to the right hand or to the left, with my finger or my thumb (whereof the reaſon is intimated above, where we mentioned almoſt the like caſe in glaſſes) and having ſometime before taken up a weight, which we conjectured to be not much inferiour to that laſt named, we preſently for trial-ſake held the marbles with their edges downwards; and found, that thoſe, that in an horizontal poſition could not be drawn aſunder by ſo great a weight, did in another poſture preſently fall aſunder by their own weight, which made one readily ſlide off from the other to the ground. Now although we have confeſſed, that this way of meaſuring the force of the air is not accurate; yet we hope it will not be thought uſeleſs, ſince (not to mention, that by thus breaking the ice, we may make way for the happier inquiries of others) it not only ſhows us, that this preſſing or ſuſtaining force of the air, as unheeded as it is wont to be, is very great, but it may alſo aſſiſt us to conjecture, how great it is, which though we cannot hereby determine preciſely and with certainty, yet we may eſtimate it with much leſs uncertainty than otherwiſe we could.

I KNOW, that the Peripateticks, and the generality of the ſchool-philoſophers, will confidently aſcribe the ſticking of the marbles, not to the cauſe we have aſſigned, but to nature's abhorrency and fear of a vacuum. But not to engage our ſelves now in a diſquiſition, that, when we diſcourſed of fluidity, we did (for the reaſons there expreſſed) decline to meddle with; we will, without diſputing whether or no nature either can at all admit, or do abhor a vacuum, content our ſelves to confirm the explication given of this phænomenon by theſe two conſiderations. The one, that if nature did ſo violently oppoſe a vacuum as is pretended, it is not likely, that any force whatſoever, that we could employ, would be capable to produce one; whereas in our caſe we find, that a little more weight added to the lower of the marbles is able to ſurmount their reluctancy to ſeparation, notwithſtanding the ſuppoſed danger of thereby introducing a vacuum. And my next conſideration is, that (according to what we have hitherto delivered) without having recourſe to any ſuch diſputable principle, a fair account may be given of the propoſed phænomenon, by the preſſure or weight of the air. And that what we have ſaid concerning the latter of theſe may be entertained with the leſs difficulty, let us ſuppoſe, that when the marbles ſtick well together, the lowermoſt of them, or the appendant weight were faſtened to the ground: for in this caſe there appears no reaſon to believe that their power to reſiſt ſeparation would be leſs than it was before. And yet it ſeems evident, that the uppermoſt marble would not be perpendicularly pulled up but by ſuch a force as were at leaſt (I ſay at leaſt) able to lift up a weight equal to that of the laſt mentioned marble, and of a pillar of air having the ſtone for its baſe, and reaching to the top of the atmoſphere; ſince at the inſtance of revulſion, before the air can get in, and ſpread it ſelf between the ſtones, there is not, for aught appears, any ſuch body under the upper marble, as can help the hand to ſuſtain the weight both of that marble and the incumbent cylinder of the atmoſphere, which

which then gravitates upon it, and conſequently upon the hand; becauſe there is no air, nor other equivalent body underneath it, to ſuſtain its part of the weight, as the lower air is wont to do in reference to the heavy bodies that lean on it, and to the weight of the incumbent air. And therefore we need not much marvel, if when only a leſs weight than that of the forementioned pillar of the atmoſphere hangs at the lower marble, it ſhould be capable of being drawn up by the uppermoſt, rather than ſuffer a divulſion from it. As we ſee, that when two bodies being faſtened together, are endeavoured to be drawn aſunder by forces or weights not able to ſeparate them, they will uſually both of them move that way, towards which either of them is the moſt ſtrongly drawn. On which occaſion, I remember what I have ſometimes obſerved in one of the ways of trying the ſtrength of load-ſtones; for if the load-ſtone be able to take up more than its own weight, you may as well lift up the load-ſtone by a knife, as a knife by the load-ſtone. And though one accuſtomed to judge only by his eyes, would have imagined, that when I held the great weights formerly mentioned ſuſpended in the air, there was no ſtrong endeavour to pull up the upper marble from the lower, becauſe my hand being for a while held ſteady, ſeemed to be at reſt; yet he will eaſily be invited to ſuſpect, that in ſuch a thought there may be a great miſtake, who ſhall conſider, that neither did the weight ſenſibly appear to pull the lower marble downwards, though my hand aſſured me that the weight had not loſt its gravitation. And if I ſhall add, that once, when the weight after having been lifted up into the air, was caſually ſo looſened from the upper marble, as ſuddenly to drop down, my hand, unawares to me, was by the force of that endeavour, it juſt before employed to ſuſtain the fallen weight, carried up with ſuch violence, that I very ſenſibly bruiſed it by the ſtroke it gave againſt the face of a by-ſtander, who chanced out of curioſity to hold his head over the marbles.

AND here it will not be impertinent to bring in an experiment that I once deviſed, not only for other uſes, but to illuſtrate the ſubject we have been hitherto treating of. The trial I lately found regiſtered among my *Adverſaria*, in theſe terms. A braſs valve of about an inch diameter was with cement well faſtened to the ſhorter leg (which was but of very few inches in length) of a long glaſs ſiphon left open at the end of the other leg. This valve being let down to the bottom of a tall glaſs body full of water, ſo that it was (if I much miſ-remember not) between a foot and half a yard beneath the ſurface of the water, when there was let in as much water into the pipe, as reached in that as high as the ſurface of the external water in the tall cucurbite: then about an ounce weight was put into the oppoſite ſcale of a ballance, to the neighbouring ſcale, whereof one end of a ſtring was tied, whoſe other end was faſtened to the ſaid valve, whoſe parts would be thereby drawn aſunder. But when the water was emptied out of the pipe, and the valve was let down to the former depth, there was requiſite about 5 ounces, that is 4 ounces more than formerly, to disjoin the parts of the valve, and let the water get in between. And when (the ſiphon being freed from water) the valve was lifted higher and higher, together with the pipe, there needed leſs and leſs weight to make a disjunction; two ounces of additional weight (to the one ounce requiſite to counterpoize the cover of the valve it ſelf) on the water ſufficing to lift up the cover, when the valve was held about half way, between its lower ſtation, and the top of the water; a ſingle ounce ſufficing afterwards, and half an ounce of additional weight proving enough to disjoin the parts, when the valve was held but a little beneath the ſurface of the liquor.

THIS relation of an experiment, which I afterwards ſhowed to many vertuoſi, will perhaps ſeem ſomewhat dark to you without a ſcheme; but if you conſider it attentively enough to apprehend it thoroughly, I preſume it will ſhow you, that whether or no there be, upon any other ſcore, a repugnancy to the ſeparation of ſmooth bodies joined by immediate contact; yet certainly there may be a great repugnancy upon the bare account of the gravity of the medium, wherein the divulſion is attempted. For in our caſe the fuga vacui, if there be any, ought to reſiſt the ſeparation of the parts of a valve ſtill kept under water, as much near the top of the water, as at the bottom. And therefore the great difference found in that reſiſtance at thoſe different places may be attributed to the preſſure of the ambient water, that thruſt them together. And though it be true, that air is an exceeding light body in compariſon of water; yet in divers trials I have found the diſproportion in gravity of thoſe two fluids not to exceed that of 1000 to 1. So that conſidering how many miles, not to ſay ſcores of miles, the air may reach upwards, there ſeems no abſurdity at all to ſuppoſe that the bare preſſure of it againſt the marbles formerly mentioned may keep them as coherent as we found them to be*.

BUT it is now high time to look back to that part of our diſcourſe, which the conſideration of our marbles has ſo long inticed us from directly proſecuting. Although then it may from the paſt diſcourſe be conceived, that in bodies of ſenſible bulk, whoſe ſmooth ſurfaces touch one another, the force of the air does mainly make them cohere; yet it ſeems, that generally in bodies (whether greater or ſmaller)

* But ſince this I have been able to make an experiment, that does ſufficiently confirm the former doctrine. For having ſuſpended the two coherent marbles in a capacious glaſs, whence by a certain contrivance, the air could little by little be drawn out, we found, as we expected, that whilſt there remained any conſiderable quantity of air, in the glaſs, the lower marble continued to ſtick to the other, the preſſure of the remaining air, though but weak, being yet ſufficient for the ſuſtentation of the lower marble, which it was not after the air was further withdrawn. And if when the disjunction was made, the upper marble were by another contrivance let down upon the lower, ſo as to touch it as before; though whilſt the external air was kept out of the glaſs, the upper marble might eaſily be raiſed without taking up the lower with it; yet when the outward air was let in, the marbles were preſſed together, and became again ſtrongly coherent.

ſmaller) it is a ſufficient cauſe of coheſion, that the parts of the body are at reſt by one another, though perhaps the entire concretion be removed from place to place. For bodies of ſenſible bulk being either fluid or conſiſtent, and it being (as above we have taught) the chief requiſite of a fluid body, that its ſmall parts be in motion, there ſeems not any thing neceſſary to keep a body from being fluid, and conſequently to keep it a firm body, but that its contiguous parts be in a ſtate of reſt.

I KNOW, that almoſt all philoſophers both ancient and modern require ſomething elſe than the reſt of the parts (of which ſcarce any of them takes the leaſt notice, as of a thing conducive to firmneſs) to the keeping together the parts of a dry and ſtable body. But although to engage very far in ſuch a metaphyſical and nice ſpeculation were unfit for me, (at leaſt at preſent, when I am but to endeavour to explicate fluidity and firmneſs in the ſenſible bodies we converſe with;) yet we dare not quite ſkip it over, leſt we be accuſed of overſeeing it. The greater number of contemplators aſcribe the effect under conſideration to a certain ſubſtantial form, to which they aſſign, among other offices, that of keeping all the parts united into one body. But what this form is, and by what means it unites the parts ſo ſtrongly in a diamond or a ruby, *&c.* and ſo looſely in tallow, camphire, or the like ſlight concretions; and how the ſubſtantial form continuing the ſame in water and ice, the ſame matter may eaſily and frequently become by turns a hard and a fluid body; how theſe, I ſay, and divers other things are effected by the forms of ſolid bodies, is to me, I confeſs, at leaſt as difficult to conceive, as to imagine without it a cauſe of coheſion in the parts of a dry body.

OTHER learned men there are among the modern naturaliſts, who have recourſe ſome of them to a ſpirit, which penetrating and faſtening to each other all ſubſtances corporeal, unites them into one world; but others fancy rather a certain cement or glue, whereby they conceive the parts of bodies to be made as it were to ſtick to each other. But as for this laſt hypotheſis, it would be conſidered, that though glue is made uſe of to join together bodies of ſenſible bulk, yet glue it ſelf being a body, that is ſo too, it muſt alſo it ſelf conſiſt of leſſer parts ſticking to one another; which allows me to demand the cauſe of the mutual coherence of thoſe parts. And if it be anſwered, that they likewiſe ſtick together by the intervention of ſome more ſubtile glue, I ſhall again repreſent, that this glue alſo muſt conſiſt of corporeal parts; and therefore I ſhall further demand how theſe alſo ſtick together: and if the like anſwer be again made me, I ſhall ſtill renew the like demand, till at length the anſwerer be reduced to confeſs, that parts of matter ſo very ſmall cannot be reaſonably ſuppoſed to be kept together by a cement. And if the corpuſcles, that make up the fineſt glue imaginable, are not kept together by a cement, we may be allowed to aſcribe their adheſion to the immediate contact and reſt of the component parts, (which is a cauſe intelligible, and at leaſt probable) till ſome other ſufficient cauſe be aſſigned, which I do not take that to be, which is taught by the patrons of the firſt hypotheſis lately mentioned, concerning a ſpirit diffuſed through the maſs of matter. For not to mention, that the agility of a ſpirit ſeems not ſo proper a qualification for that, which is to faſten bodies together, we may conſider, that this ſubſtance which is called a ſpirit, is indeed but a ſubtile body. And why therefore may not the minute parts of other bodies, if they be conveniently ſhaped for adheſion, ſtick to one another, as well as ſtick to this ſpirit? And I ſhould here alſo demand, how the parts of this ſpirit are kept faſt to one another. If any ſhould anſwer, that this ſpirit conſiſts of parts, which are inſeparable, and yet perhaps of a hooked ſhape, which fits them to faſten themſelves to the bodies they take hold of, and thereby thoſe to one another; this would be to propoſe ſuch a new notion of the diffuſed ſpirit, as I know not whether thoſe, whoſe opinion I have been examining, did ever dream of, or would be content to adopt: and ſure, according to this hypotheſis, there muſt be a wonderful plenty of theſe little ſpirits in the groſſeſt bodies; and ice for example, which is thought ſo deſtitute of ſpirits, muſt be well nigh half made up of them: for theſe little ſpirituous parts can faſten no parts of other bodies together but thoſe they touch, ſince otherwiſe the parts of other ſorts of matter, if but contiguous, might cohere without theſe, which is againſt the hypotheſis. And ſince each of theſe ſmall ſpirituous corpuſcles, if I may ſo call them, being really a natural body, and by conſequence neceſſarily diviſible, at leaſt by thought, into parts, I ſhall aſk the propoſers of this new notion of ſpirit, upon what account this corpuſcle can be indiviſible; I mean, what it is, if it be not reſt and immediate contact, that hinders, but that the parts (or deſignable parcel of corporeal ſubſtance) which are diviſible by thought, ſhould be always kept together, and never be actually divided. I am not averſe indeed from granting, that they may almoſt always eſcape diſſolution: but I am apt to ſuſpect, that may be, becauſe that by reaſon of the extreme ſmallneſs, and the reſt and ſtrict contact of their parts, they can ſcarce ever meet with an agent minute and ſwiftly enough moved, to be able to ſhatter them, or diſſociate the combined parts. For to ſay, that it is the nature of every ſuch corpuſcle to be indiviſible, is but to give me cauſe to demand how that appears; for ſo important an aſſertion needs more than a bare affirmation for proof.

AND if two of theſe corpuſcles, that are preſumed to be indiviſible, ſhould, being ſmooth and of the ſame figure, (as for example cubical) happen to lie upon one another, and a third ſhould likewiſe chance to be fitly placed upon the uppermoſt of the two, what ſhould hinder, but that this aggregate may by the violent knock of ſome other corpuſcles be broken in the midſt of the whole concretion, and conſequently in the middlemoſt body? For ſuppoſe them as adamantine as you pleaſe, yet ſince corpuſcles as hard as they are, can be made

very violently to knock againſt them; why may not theſe grate or break the middlemoſt corpuſcles, or any of the others? as we ſee that diamonds themſelves may be reduced to powder by other diamonds, though not (as artificers verſed in the trade inform me) by attrition with any other ſtone. To prove, that the coheſion of the middlemoſt of the three lately-mentioned ſmall deyes with the other two, the one above it, the other below, is not ſo ſtrong as that of the parts of that middlemoſt corpuſcle, notwithſtanding that the contact between each two adjoining bodies is ſuppoſed to be full, (for ſo it muſt be in ſuch bodies, though not always in others viſibly greater, in which ſome ſubtiler ſubſtance may be ſuppoſed to come in part between them;) to prove this, I ſay, there muſt be aſſigned ſome better cauſe of the coheſion of the matter in one part of the propoſed body than in the other. And it cannot with probability be pretended, that a corpuſcle preſumed uncapable to be divided ſhould conſiſt of hooked parts: and if that ſhould be pretended, yet even theſe hooks alſo being true bodies, the queſtion would recur concerning them, and be ſtill renewable *in infinitum*. If it ſhould be ſaid, that theſe minute bodies are indiſſoluble, becauſe it is their nature to be ſo; that would not be to render a reaſon of the thing propoſed, but in effect to decline rendering any. And though I know, that in every hypotheſis about the principles of things, ſomething is allowed to be aſſumed, as not being to be explained or proved by any thing more primary than it ſelf; yet I know not whether this excuſe be proper in our caſe, wherein it ſeems, that the entireneſs and permanency of any parcel of matter, how minute ſoever, may be probably enough deduced from the immediate contact, the reſt and the extreme littleneſs of its deſignable parts. And if for a laſt refuge it ſhould be ſaid, that the deſignable parts of theſe corpuſcles are therefore unſeparable, becauſe there is no vacuity at all intercepted between them; beſides that this is contrary to the ſuppoſition formerly made; for ſuch extremely minute deyes as we imagined to be one upon another, having their ſurfaces, according to our poſtulatum, flat, ſmooth, and exquiſitely congruous, could no more than the parts of either of the three corpuſcles have any vacuity intercepted between them: beſides this, I ſay, this is both to ſuppoſe a vacuum in all diviſible bodies, and that too as the cauſe of their being ſuch, and to decline the former hypotheſis touching the uſe of this ſpirit, and take ſanctuary among the atomiſts, to whoſe opinion about the account, upon which thoſe bodies they call atoms are not diſſipated, although ſome of the conſiderations we have alledged againſt the newly-examined opinion may in part be applied; yet divers of their other opinions do ſo fairly comport with the generality of our experiments in theſe notes touching *Fluidity and Firmneſs*, that I am willing to decline claſhing with them, by not purſuing now any further a diſquiſition, which, as I ſaid a while ago, is not neceſſary to my preſent deſign: eſpecially, ſince the dim and bounded intellect of man ſeldom proſperouſly adventures to be dogmatical about things, that approach to infinite, whether in vaſtneſs or littleneſs. Nor indeed would I have that looked upon as a reſolute declaration of what I think of ſo abſtruſe a ſubject, which I have rather propoſed to avoid ſaying nothing, where I ſuppoſed it expected I ſhould ſay ſomething.

THE other thing then, which in our deſcription of a firm body we mentioned as capable to make it ſo, is the texture of the parts (whether homogeneous or not) that conſtitute it; and though the juxta-poſition and reſt of theſe parts may poſſibly alone ſuffice to make the body ſtable; yet this texture ſeems to be the moſt uſual cauſe of ſtability, and ſometimes alſo it may ſuper-add a degree of that quality to that, which bodies may have upon the former account only. For, though whilſt the parts of the body are actually at reſt, it cannot be fluid, yet thoſe parts, if they cohere to one another but by reſt only, may *cæteris paribus* be much more eaſily diſſociated and put into motion by any external body actually moved, than they could be, if they were by little hooks and eyes, or other kind of faſtenings intangled in one another; it being often neceſſary in this caſe violently to break off theſe faſtenings, before the little bodies faſtened together by them can be disjoined, and put into ſuch a ſeparate motion, as is requiſite to the conſtituting of a fluid body.

WE formerly made uſe of that familiar ſubſtance, the white of an egg, to illuſtrate the nature of fluidity: let us now try, whether it will alſo aſſiſt us in our inquiry after the cauſes of ſtability. When an egg is made hard by boiling, ſince whether we ſuppoſe this induration to be effected by bare motion or impulſe, or elſe by the inſinuation of fiery corpuſcles; ſince I ſay there is nothing, that appears to get in at the ſhell, unleſs perhaps ſome calorific atoms, and, perchance too, ſome little particles of the fluid water it is boiled in, it is not eaſy to diſcover, from whence elſe this change of conſiſtency proceeds, than from a change made in the texture of the parts, whereby they are connected and diſpoſed after a new manner, fit to make them reciprocally hinder the freedom of each other's motions. But if inſtead of hardening the whites of eggs by the heat of the fire, you beat them very well into froth, you may perceive that froth to emulate the nature of a ſtable body: for not only you may raiſe it up to a pretty height, and make it retain a ſharp top almoſt like a pyramid; but I remember I have, for curioſity-ſake, made with a little care a long and proportionably thick body of theſe bubbles hang down from my finger without falling, like an icicle from one of the reeds of a thatched houſe; and yet in this there appears not any alteration to be made in the fluid body, ſave a meer mechanical change of the diſpoſition of its parts: which may be confirmed by water beaten into froth, for there the heaped bubbles will quickly ſubſide and fall back into water of the very ſame conſiſtence it was of before.

Now there may be ſeveral things, whereby

a body may be put into ſuch a texture, as is convenient to make it firm or ſtable. And of theſe, before we conſider of them particularly, it will be fit to take notice in general, that for the moſt part it is not from any of them ſingle, but from two or more of them concurring, that the ſtability of concretions proceeds.

THE firſt and chiefeſt of theſe ſeems to be the fitneſs of the ſhapes of the component particles to faſten to each other; as if ſome were figured like the handles of buckets, and others like the hooks, that are wont to be employed to draw them up out of the well, or ſome like buttons, others like loops, ſome like male, others like female ſcrews (as mechanicians ſpeak) or as if many together were ſo variouſly branched, that their parts may be ſo interwoven one within another, as not to be eaſily ſeparable (as we often ſee in a well-made dry hedge, of which if a man go to pull away one bough, he ſhall often be unable to do it without pulling away with it divers others, whoſe ſlender twigs will be intangled with it.) An eminent example of the power of the bare texture of many ſmall bodies (even ſuch as each of them apart is not, perhaps, extraordinarily ſhaped for ſuch a purpoſe) to make a ſtable one, is afforded us by ropes and cables; where only by twiſting together and wreathing the ſlender and flexible threads the cable is made up of, they are ſo well, as it were, wedged in between and faſtened to one another, that they conſtitute a body not to be broken by the weight of an iron anchor, nor, perhaps, by the force of a ſhip violently driven on by the fury of the winds and waves. This figuration of the corpuſcles, that make up conſiſtent bodies, ſeems to have been the chief, if not only, cauſe of their conſiſtence, in the judgment of the antient Atomiſts, this being the account, that is given of it by *Lucretius:*

Denique quæ nobis durata ac ſpiſſa videntur,
Hæc magis hamatis inter ſeſe eſſe neceſs' eſt,
Et quaſi ramoſis alte compacta teneri.
In quo jam genere imprimis adamantina ſaxa
Prima acie conſtant, ictus contemnere ſueta,
Et validi ſalices, ac duri robora ferri,
Æraque quæ clauſtris reſtantia vociferantur.

AND indeed, ſo innumerable may be the correſpondent figures, which are fit to faſten bodies to one another, that it is very poſſible, that two bodies, whereof each apart is fluid, may upon their conjunction immediately intangle their parts in one another, and thereupon acquire ſuch a new texture, that their parts cannot as formerly diſſociate themſelves at pleaſure, and move along one another's ſurfaces, nor conſequently flow after the manner of liquors, but are ſo connected or intangled, that the motion of one of them will be reſiſted by many, and ſo the whole body will become firm or ſtable. Something like this may be ſeen in the experiment mentioned by our author, where he teaches, that the diſtilled liquor of nitre, and that made *per deliquium* out of fixed nitre, will preſently, upon their mixture, in part concoagulate into ſaline, and conſequently ſtable, bodies; but this ſeeming only a re-union of the ſaline particles, that did, though inviſibly, ſwim up and down in the aqueous parts of the mingled liquor, which after this ſeparation remains both more copious than the ſaline parts, and as fluid as before, we will add a noble inſtance (mentioned to another purpoſe by *Lully* and *Hartman*) to declare, how much the firmneſs of bodies depends upon their texture. If you take then the alcohol or highly-rectified ſpirit of wine, and exquiſitely dephlegmed ſpirit of urine, and mix them in a due proportion, (as I remember the laſt time I made the experiment I took about equal parts by gueſs, though two of the former to but one of the latter, if this be excellent, be a better proportion;) you may in and about a minute of an hour turn theſe two fluid liquors into a conſtant body; and I confeſs it was not without pleaſure, that I have immediately upon the ſhaking of theſe two liquors ſeen them ſhoot into the likeneſs of ſnow, and acquire ſuch a conſiſtence, that I could without ſpilling the mixture turn the veſſel, that contained it, upſide down.

BUT I dare not expect to have this experiment believed, even by moſt of them that ſhall try it, experience having taught me, that it will not ſucceed, unleſs the ſpirits of urine and of wine be both of them more exactly dephlegmed, than is uſual even among chymiſts. Yet ſo much more does this coagulation ſeem to depend upon the ſalt of urine as of ſuch a texture, than barely as urinous, that we will add that, as the ſpirit of fermented urine is not (whatſoever ſome eminent chymiſts may think or ſay) ſo indiſpenſably requiſite, but that my curioſity leading me to try, whether other liquors, which I ſuppoſed to be of a reſembling nature, might not ſerve the turn, I found, that ſufficiently-rectified ſpirit of hartſhorn (to mention that alone here) may be made to ſupply its place: ſo I endeavoured to make it probable by this *, that having tried a certain method (though that may ſeem ſtrange to moſt chymiſts) of ſo ordering urine, that without ſtaying at all to ferment or putrefy it either forty days, or half ſo many hours, I can make the volatile or ſaline ſpirit aſcend firſt in diſtillation, though I uſe but ſome ſuch gentle heat as that of a bath: having, I ſay, by this means diſtilled a very ſtrong ſpirit of unfermented urine, and rectified it too, I found, as I expected, that I could not by any means make it coagulate with ſpirit of wine, which ſeemed to proceed from the differing texture of this ſpirit from that of fermented, or rather putrefied, urine; ſince I had added nothing to the freſh urine I diſtilled, but what was extremely fixed, and belonging (as chymiſts ſpeak) to the mineral kingdom. Whereupon having had the curioſity to inquire of ſome of my chymical acquaintances, I found, that, they complained, that they had not been able to coagulate ſpirit of wine with the ſaline ſpirit made of meer urine, without any addition at all, when they diſtilled that urine without a previous putrefaction

* This way the author afterwards publiſhed in another book.

faction (which is not wont to be perfected under ſix weeks or thereabouts.) But to return to our coagulum, we will annex, that this is further remarkable in this experiment, that this white coagulated ſubſtance, being put into a glaſs veſſel exactly ſtopt and kept in a gentle heat (which yet it ſelf is not, perhaps, neceſſary, though expedient) for ſome weeks or months, will at leaſt for the greateſt part by much (for I have not yet totally ſeen it do ſo) reſume the form of a limpid liquor; as if either all the crooked particles, that connected the ſmall coalitions of the vinous and urinous corpuſcles to one another, were, by the motion they were put into by the external heat one after another, broken off, or elſe the ſame little concretions (for the menſtruum ſeems to conſiſt chiefly of them, being able to perform other matters than either of the ſingle liquors whereof it is conſtituted) either aſſiſted by outward warmth, or enabled thereto by ſome other cauſe of mobility, did, after many and various attempts to clear themſelves of each other, little by little ſo unbend or break off the crooked particles, that intangled them, as at length to extricate themſelves, and become capable of freely ſhifting places among themſelves, and ſo of the form of a liquor.

AND here I ſhall add a couple of experiments, for the ſake of their affinity with ſome parts of the newly-recited experiments about the vino-urinous coagulate.

AND firſt it ſeemed to me worth trying, whether ſome acid ſalts, being duly ordered, would not concoagulate with ſpirit of wine, as well as with urinous ſalts; and having for a while digeſted together in a convenient proportion pure *ſaccharum Saturni*, made with ſpirit of vinegar, and rectified ſpirit of wine, I found the mixtures ſo changed in point of conſiſtence, that upon inclining the glaſs, which contained it, none of it would run down the ſides. But this experiment did not afterwards ſeem to me either eaſy or conſiſtent, nor is it more than one of the ways, and I doubt none of the beſt, of attempting what we have propoſed.

THE other experiment I promiſed you, relates to the reſolution of the coagulum of ſpirit of wine, (which to be performed by digeſtion requires a very long time.) And I wiſh I had not ſome reaſons to hinder me from communicating to you the way of making of it at preſent; it being an experiment, that ſeems ſomewhat ſtrange in its kind; but that part of it, which is directly pertinent to our preſent argument, you will, I truſt, believe upon my relation, which is, that by the addition of nothing but of a very fixed and very dry body (inſomuch that it will not yield any thing by the common way of diſtillation, even in a naked fire) by the ſole addition, I ſay, of this dry body, the newly-mentioned coagulum, which is alſo a conſiſtent body, may in a few hours be brought into a permanent liquor (quite diſtinct from the dry body) which, when experience firſt recommended this way to me, was of too ſubtile and penetrating a nature, not to make me expect from it conſiderable effects, both in chymiſtry and phyſick, of which imitation you may be pleaſed to take notice.

BUT to return to what I was about to ſubjoin after the mention of our coagulum, as that is an example of firmneſs produced by texture; I will here, becauſe it is not eaſy to procure ſpirits pure enough to make ſuch a concretion as that; I will here, I ſay, ſet down another way of ſpeedily hardening one fluid body by another: for if you take the white of an egg, and beat it till it become thin, and then ſhake well into it about half its quantity (perhaps much leſs might ſerve the turn) of right ſpirit of ſalt, you ſhall have in a few minutes the mixture ſo coagulated, that I remember when we turned the glaſs, wherein we made it, upſide down, not a drop of liquor did run out, though ſome hours after we obtained a little by breaking the curdled matter. And another experiment much of the nature of this is ſaid to be delivered by Sir *Francis Bacon*, who teaches to coagulate whites of eggs with ſpirit of wine: and indeed, if you obſerve a circumſtance (unmentioned, that I hear of, by him) which is the ſhaking of the two bodies well together, and if your ſpirit of wine be good, the experiment will ſucceed very well; inſomuch that I remember I have made this way a coagulum, from which no liquor would drop down in about a minute of an hour. But whereas this great naturaliſt conceives this hardening of the egg's white to be performed by the heat of the ſpirit of wine, I ſhall willingly confeſs he has aſſigned the cauſe ingeniouſly, but muſt doubt, whether he have done it truly: for there are divers things, that ſeem to argue ſpirit of wine, as inflammable as it is, to abound with a piercing ſalt, and that ſuch ſaline corpuſcles may ſuffice to curdle whites of eggs, our freſhly-mentioned experiment of curdling the white of an egg with ſpirit of ſalt does ſufficiently declare; and not only we have performed the like effect with ſome other acid ſpirits, and particularly that called oil of vitriol, but it may be produced, though more ſlowly, even by a crude ſalt; for by long beating the white of an egg with a lump of allom, you may bring it for the moſt part into white curds. So that if we will allow the coagulation we treat of to be performed by the ſpirit of wine as hot, it ſeems, that that heat muſt be only ſuch, as may be aſcribed to the active particles of ſaline bodies, which yet are commonly accounted rather cold than hot. But becauſe I ſomewhat doubt, how juſtly they are reputed ſo, I will add, that I did purpoſely for trial-ſake, take the ſerum or whey, that is wont to ſwim upon men's blood after it is cold and ſettled, and indeavoured in vain to coagulate it with ſuch ſpirit of wine as would coagulate eggs; and yet this whey will at leaſt as ſoon, as (if not much ſooner than) whites of eggs, coagulate over a gentle heat of embers: which makes it doubtful, whether the effect proceed not from the greater correſpondency in texture of the ſpirit of wine with one of the liquors than with the other, rather than from the heat aſcribed to it, which did not at all coagulate the whey.

BUT

BUT although we have mentioned ſome examples to ſhew, that two fluid bodies may be aſſociated into a conſiſtent one; yet we want not an experiment to make it appear, that likewiſe by the change of texture a fluid body may be divided into two conſiſtent ones. This experiment, which we have partly taken notice of before (treating of fluidity) is, that having for trial-ſake by convenient degrees of fire diſtilled over a due proportion of the more volatile parts of ſallet oil, neither the liquor, that came over, nor the ſubſtance, that remained behind in the retort, was fluid, though the oil that yielded them had been ſo.

BUT when I put to the oil before diſtillation a convenient quantity of common ſalt, and one or two other things, that were fit to change the texture of the branched or hookt corpuſcles whereof it conſiſted; I could then obtain an oil of common oil, that both dropt into the receiver in the form of a liquor, and continued a fluid body; which may probably be of good uſe to ſurgeons, varniſhers, and men of ſome other profeſſions.

AND to make it the more likely, that by additaments of ſome ſuch nature as that newly-mentioned, ſome groſſer and cloggy parts are retained, or elſe much ſubtilized and otherwiſe altered; I ſhall add, that proſecuting a hint I happened to meet with in the diſcourſe of a wandering chymiſt, I practiſed a way ſo to defecate the dark and muddy oil of amber drawn *per ſe*, that a pretty proportion of it would come over ſo tranſparent and finely coloured, that the experiment did not a little pleaſe thoſe I ſhewed it to. And if it do not appear upon trial, that this way of preparing oil of amber does by detaining ſome parts, which, though more groſs than the reſt, may yet be no uſeleſs one, impair the remedy; and that it does not, upon ſome other ſcore, infringe the medicinal virtue of the oil, the experiment will not be unuſeful. For the liquor, that is thus prepared, is not only very diaphanous and well coloured, but ſo pure and ſubtile, that it will ſwim, not only upon water, but upon ſpirit of wine it ſelf. And it will be no deſpicable thing, if by extending or further applying this experiment to other indiſpoſed bodies, many empyreumatical oils diſtilled by ſtrong fires in retorts can be brought to emulate eſſential oils (as chymiſts call them) drawn in limbicks, as to clearneſs and lightneſs.

THE additament I laſt thought fit to make uſe of for purifying oil of amber was briefly this. ℞. two pound or ſomewhat leſs of good brandy, one pound of good ſea-ſalt, and half a pound of the oil to be ſubtilized, mix, and diſtil them together.

UPON the mention I made above of the white coagulum of the ſpirits of wine and urine, I remember what I have ſometimes obſerved in the eſſential oil of anniſeeds (as chymiſts ſpeak) diſtilled with ſtore of water in a limbick and refrigeratory; namely, that in the heat of ſummer it would remain a perfect liquor like other chymical oils; but during the cold of the winter, though they, notwithſtanding that ſeaſon, continued fluid as before, the oil of anniſeeds would coagulate into a body, though not of an uniform texture to the eye like butter (but rather almoſt like camphire) yet like it white and conſiſtent, not without ſome kind or degree of brittleneſs.

AND on this occaſion I will here inſert an experiment, which ſhould have been ſet down in that part of the former hiſtory of fluidity, where I mention, that the ſmall parts of a body may be ſufficiently agitated to conſtitute a liquor by the air or other agents not ſenſibly hot themſelves. The experiment take thus. Caſting by chance my eyes in the winter-time upon a glaſs of oil of anniſeeds, which ſtood coagulated by the cold of the ſeaſon, I preſently bethought my ſelf of making a liquor (whoſe proceſs belongs to another treatiſe) of which, as ſoon as I had prepared it, I made this trial. I melted with a gentle heat the congealed oil of anniſeeds to make it flow, and then covered part of it in another glaſs with a mixture I had provided: and having let them both reſt in the window, I found, that the meer oil being fully refrigerated again, coagulated as before; but that, which was covered with the other liquor, continued fluid both day and night, and in ſeveral changes of weather, and does ſtill remain at the bottom of the menſtruum a clear oil diſtinct from it, though I have purpoſely ſhaken them together to confound them.

AND becauſe, *Pyrophilus*, I have not diſcovered to you the menſtruum I made uſe of, I will here preſent you with a ſuccedaneous experiment made with a common liquor. I took then good clear Venetian turpentine, and having ſlowly evaporated about a fourth or fifth part of it, till the remaining ſubſtance being ſuffered to cool would afford me a coherent body, (or a fine colophony) I cauſed ſome of this tranſparent and very brittle gum (of which I have elſewhere taught you ſome uſes) to be reduced to fine powder: of which I put into pure ſpirit of wine a greater proportion, than I judged the liquor was capable of diſſolving, to the end, that when the ſpirit had taken up as much of the powder as it could, there might remain at the bottom a pretty quantity of our colophony. On which, though the menſtruum (being already glutted) could not act powerfully enough to diſſolve it, yet it might give the matter (which it had already ſo far ſoftened, as to reduce it into a coherent maſs) agitation enough to emulate a fluid (though ſomewhat viſcous) body. And accordingly I obtained a ſluggiſh liquor, which continued fluid, as long as I pleaſed to continue the menſtruum upon it. The like experiment I tried with clarified roſin, and with fine colophony, though but bought at the ſhops; and although the trial ſometimes ſucceeded not ill, yet I found not the ſucceſs conſtant and uniform, whether becauſe the bodies to be diſſolved were not defecated and pure enough, or that I did not hit upon the beſt proportion between the ſolvent and them. But this circumſtance I ſhall not omit, that when the glutinous liquor was ſeparated from the menſtruum, it would by degrees, though but ſlowly, harden

in the air. The application of which property, for the preſervation of ſmall and very tender bodies, I ſhall not here more expreſly hint than by having barely named it. I had forgot to add, that whilſt the ſubſtance continued fluid, I could ſhake it, (as I lately told you I could the oil of anniſeeds) with the ſupernatant menſtruum, without making between them any true or laſting union.

WHICH laſt circumſtance brings into my mind another experiment, that I likewiſe forgot to add to that part of the former hiſtory of fluidity, where I take notice, that the particular textures of fluid bodies may be reckoned among the chief cauſes of their being diſpoſed, or indiſpoſed to mingle with one another. For partly to confirm this conjecture, and partly to manifeſt, that it is not univerſally true, which chymiſts are wont to think, that acid ſalts and oils will not incorporate or mingle; I took an arbitrary quantity (and, as I remember equal weight) of common oil of vitriol and common oil of turpentine, as I bought them at the druggiſts: theſe I put together very ſlowly, (for that circumſtance ſhould not be omitted) and obtained, according to my deſire, an opacous and very deep-coloured mixture, whoſe almoſt balſam-like conſiſtence was much thicker than either of the liquors that compoſed it. (The like experiment alſo ſucceſsfully tried with ſome other chymical oils, but found none preferable for this purpoſe to oil of turpentine.) And to make it probable, that the diſpoſition of theſe liquors to mingle thus preſently together depended much on their texture, we made the mixture be warily diſtilled over, (for elſe the experiment will ſcarce ſucceed) and thereby obtained, (as we elſewhere mention to another purpoſe) a certain groſs ſubſtance, which was that, which ſeemed to mediate the former union betwixt the two liquors. For this ſubſtance being ſeparated, and thereby the texture of one of the liquors (or perhaps both) being changed, the liquors (which came over very clear into the receiver) ſwam upon one another; nor have I ſince been able by ſhaking them together to confound them for any conſiderable time, but they preſently part again, and do to this day remain diſtinct as well as tranſparent. But after having forgot to ſet down theſe things in their proper place, I muſt not forget alſo, that to employ here more words about them were to digreſs.

To this then annex we, that the liquor we elſewhere mention ourſelves to have diſtilled from benzoin, has been, and is ſtill, ſubject to much more frequent viciſſitudes of fluidity and firmneſs: for part of it all the year long continues in the form of a blackiſh oil, and the reſt, according as the ſeaſon of the year or of the day makes the weather cold or hot, frequently changes its texture, ſometimes appearing perfectly the ſame with the newly-mentioned oil, and ſometimes ſhooting into clear and variouſly-ſhaped cryſtals, which faſten themſelves to the bottom and ſides of the veſſel, till a warmer part of the day or of the ſeaſon reſolves them again into a liquor. And theſe two laſt obſervations may alſo ſerve to confirm what we formerly taught, that the fluidity of ſome bodies depended almoſt wholly upon the various agitation of their parts: for in theſe inſtances the parts of the anniſeeds and thoſe of the benzoin, upon the operation or abſence of the languid heat of the ambient air, ſometimes agitating them, and ſometimes ſuffering them to reſt, did conſtitute a fluid or a conſiſtent body. And having thus taken notice of this upon the by, we will add to the other examples mentioned under this ſecond head that, which it afforded us to our preſent purpoſe by ſalt-petre, which being diſſolved in a ſufficient quantity of common water, will ſeem to be loſt in it, and to conſtitute with it one uniform fluid ſubſtance; but if a competent quantity of that water be boiled (or permitted to exhale) away, and the remaining liquor be ſuffered to reſt a while, eſpecially in a cool place, the ſaline particles will be re-uniting themſelves, and by the excluſion of the aqueous parts, conſtitute ſtable and determinately-figured icicles or cryſtals.

THE conſideration of this may ſuggeſt to us another way, that ſeems quite contrary to the former, whereby ſome bodies may become firm and ſolid; and that is by the intermingling of a due proportion of water or ſome other liquor. For, though the ſmall parts of ſuch fluid bodies, being themſelves in motion, are apt to give thoſe of others ſuch an agitation as we have formerly taught, that fluidity principally depends on; it ſeems, that the admiſſion of any liquor muſt rather conduce to the making of a body fluid than conſiſtent: yet if we conſult experience, it will inſtruct us otherwiſe; for when I have taken either an equal or a double weight of oil of vitriol and diſtilled it warily from running mercury, very much the greater part of the liquor would come over, and leave behind it a very white powder conſiderably fixed. And if we examine that familiar production of chymiſtry *mercurius dulcis*, (which they now uſe to make, by ſubliming together of two parts of crude mercury, with but one of ſublimate, which conſiſts chiefly of mercury already) we may find that in that, which is counted the beſt, the fluid body of quickſilver is ſo contexed with the ſalts it carries up in ſublimation, that the dry and brittle body they compoſe may contain far more (perhaps twice more) quickſilver than ſalt. And other experiments may perſuade us, that the mixture of a convenient liquor may cement bodies into one hard concretion, which would ſcarce be compacted together otherwiſe. Nor is it againſt reaſon, that it ſhould be ſo; for there may be differing qualifications required to a body, whilſt it is conſtituting, and when it is conſtituted; and though the motion of the parts, that make it up, oppoſe the firmneſs of a formed body, yet it may conduce to the making of a firm body. For when a great many hard corpuſcles lie together looſe and incoherent, they do, as we formerly noted, emulate a fluid body; whereas by the mixture of a liquor, thoſe looſe corpuſcles being for a while diſſociated and put into motion, they may after many evolutions apply themſelves to one another

ther after that manner, that is moſt requiſite to make them touch one another cloſely, and according to a greater ſurface. Whereupon it often follows, that the liquor, in which they did formerly ſwim, is either ſqueezed out upon their cloſing, or elſe ſo diſperſed in ſmall particles, and diſpoſed of among thoſe of the harder corpuſcles, that they are unable to agitate them, or prejudice their mutual coheſion.

AND here to dilucidate the ſubject under conſideration by an inſtance, that ſeems very pertinent to it, we will make a further uſe of the experiment formerly mentioned touching the burning of alabaſter. For if the powder, after it has done boiling, and has been ſufficiently burnt, and kept ſome hours (the moſt experienced artificers obſerving, that it is not ſo convenient to employ it preſently after it is taken off the fire) be well beaten and tempered up with fair water almoſt to the conſiſtence of thin pap, if the powder have been rightly prepared and ſkilfully tempered, you ſhall ſee that fluid ſubſtance in a few minutes of an hour begin to ſet (as the tradeſmen ſpeak) that is, to exchange its fluidity for firmneſs; ſo that if it were before caſt into a mould, it will perfectly retain the figure of the internal ſurface thereof.

Now that in our mixture there is for a while ſuch an agitation of the hard parts produced upon the affuſion of the water, and afterwards an excluſion of the ſuperfluous water, we may confirm partly by this, that when any conſiderable quantity of burnt alabaſter is tempered up with water, the mixture after a little time grows ſenſibly hot, and ſometimes continues ſo for a pretty while; and partly alſo by this, that having purpoſely for trial's ſake filled a new and good glaſs-phial, containing about half a pint, or pound, with the mixture we ſpeak of, and when it was top full, ſtopped it up very cloſe, the liquid mixture within leſs than half an hour cracked the phial (though ſtanding in a window) in ſeveral places, and at thoſe crevices diſcharged it ſelf of about a ſpoonful of clear water; the remaining mixture retaining perfectly the figure and dimenſions of the phial, and growing as hard as chalk, or ſomewhat harder, inſomuch that we were fain to imploy ſeveral ſtrokes with a ſtrong iron to divide the maſs.

AND let me here add, that ſome other ſubſtances may this way afford much ſolider bodies than burnt alabaſter does; and therefore it may be a thing of good uſe to inquire out and try what other bodies, eaſily to be procured, may be thus brought to a new and laſting ſolidity. For the learned hydrographer, *Fournier*, ſpeaking of thoſe dams or digues (as he calls them in his language) which are ſometimes made in the ſea to ſecure ſhipping, (as I have ſeen at the port of *Genoa* and elſewhere) after having told us, that the Romans made the faireſt harbours in the world by the help of a certain ſand to be met with at *Cuma* and *Puteoli* in the kingdom of *Naples*, which ſand mingled with a third part of quick-lime acquires in the water a flint-like hardneſs; ſubjoins this obſervation of his own, * *J'ay veu, &c.* that is, I have ſeen (ſays he) in *Flanders* near *Tournay* a certain ſort of aſhes of lime made of marble, which was excellent for any kind of work made in the water. For having made a bed of great ſtones, they caſt upon them whole bags full of ſuch aſhes inſtead of mortar, and the water betwixt the ſtones having tempered up theſe aſhes, petrified them to that degree, that in a ſhort time they became as hard as marble. Thus far he. But to purſue our former diſcourſe.

THAT alſo, which we intimated of the conduciveneſs of the various tumblings to and fro of the hard particles to their uniting into one firm concretion, ſeems confirmable by what we have obſerved in ſome ſaline liquors, eſpecially certain parcels of ſpirit of hartſhorn, which whatever were the conſtitution of the ambient air, remained fluid ſome of them for many months, after which the ſaline corpuſcles began to ſhoot at the bottom of the remaining liquor into exquiſitely-figured cryſtals, which at length grew copious enough. For this ſpontaneous coagulation of the little ſaline bodies happening ſo late, it ſeemed, that it was preceded by almoſt innumerable evolutions, which were ſo many and ſo various, that at length the little bodies came to obvert to each other thoſe parts of themſelves, by which they might be beſt faſtened together and conſtitute a firm body. Which conjecture ſeemed the leſs improbable, becauſe we could not well imagine, that this coagulation proceeded (as that of diſſolved alum and other ſalts is wont to do) from the evaporation of the ſuperfluous liquor; for the glaſſes, wherein what we have mentioned happened, being carefully ſtopped, there was no danger of ſuch an avolation; and if any thing could get away, it muſt have been the ſubtile, peircing and fugitive ſpirit, (which indeed, as my noſe had informed me, does oftentimes penetrate ordinary ſtopples) for the flying away of thoſe volatile parts would only have left the remaining liquor more aqueous. And it is well known to thoſe, that deal with ſuch kind of liquors, that the more aqueous they are, the leſs apt they are to cryſtallize. And however it will ſerve our turn, that there was but an inſenſible diminution of the liquor upon the receſs of whatever it was that got through the cork.

To the ſame purpoſe I remember alſo, that having in a cryſtal phial carefully kept a pretty quantity of well-coloured tincture of amber, made with pure ſpirit of wine, it remained fluid for a year or two, and during that time preſented us with a ſtrange phænomenon, that belongs to other papers †. But having been abſent for two or three years from the place where we locked it up, we found, when we came again to look upon it, that though it had formerly remained fluid ſo long, yet ſeveral yellow lumps of amber, almoſt like beads, with one ſide flat, had here and there faſtened themſelves partly to the bottom, and partly to the

* *Hydrograph. du P. G. Fournier*, Lib. II. Cap. 6.

† This phænomenon is partly deſcribed at large in one of the author's *Phyſico-Mechanical Experiments*.

the ſides of the glaſs; the reſt of whoſe internal ſurface continues yet tranſparent.

ANOTHER thing, whereby bodies become ſtable, is, the admiſſion of adventitious corpuſcles into their pores and receſſes. And of the ways, by which theſe foreign corpuſcles may bring the ſubſtance they invade to be compact, theſe four appear the chief.

FIRST then, the adventitious corpuſcles we ſpeak of may produce ſtability in the matter they pervade, by expelling thence thoſe voluble particles, which, whilſt they continued in it, did by their ſhape unfit for coheſion, or by their motion oppoſe the coalition, or diſturb the reſt of the other particles whereof the body conſiſted. But of this having already diſcourſed, proceed we to what is to follow.

IN the next place then, foreign bodies may contribute to the ſtability of a ſubſtance they get into, by hindering the motion of the little bodies, that conſtitute it.

AND thirdly, ſuch advenient bodies, eſpecially if they be not of the ſmalleſt ſize, may produce a firmneſs in the ſubſtance, which they get into, by conſtituting with the particles it conſiſts of corpuſcles more unapt for motion, and fitted for mutual coheſion.

THESE two we mention together, becauſe that very often nature imploys them together, for the introducing of ſtability into matter.

TO theſe ſeems to be reducible the way of turning the fluid body of milk into curds by the mixture of a little runnet; whoſe ſaline particles pervading the body of the milk, do not only make a commotion in the parts of it, but faſten the branched particles of it to one another, and with them conſtitute a body of another texture than was the milk; and the weight of theſe curdled bodies reducing them by degrees into a cloſer order, does, whilſt it preſſes them together, ſqueeze out the thinner and more ſerous liquor, which the runnet was unable to coagulate, and which being thus ſever'd from the groſſer parts of the milk, may well be more fluid than milk it ſelf is wont to be. And that there is ſome coalition of the particles of the runnet with the coagulated ones of the milk, may appear by the complaints, that houſewives ſometimes make of their dairy-maids, that the cheeſes taſte too ſtrong of the runnet, when too great a proportion of it has been mingled with the milk. And though we aſcribed the curdling of the milk to the ſaline particles of the runnet, we ignore not, that, not only common runnet, but alſo divers juices of herbs will curdle milk, as is well known in thoſe parts of *Italy*, where cheeſe is made without runnet. But we made eſpecial mention of the ſaline corpuſcles of the runnet, becauſe really houſewives are wont to ſalt it, and becauſe ſaline liquors do manifeſtly and powerfully operate in the coagulation of milk, which may be curdled by juice of lemons, and I know not how many other acid ſalts. And to manifeſt yet further the coagulative power of them, we have ſometimes in about a minute of an hour arreſted the fluidity of new milk, and turned it into a curdled ſubſtance, only by dexterouſly mingling with it a few drops of good oil of vitriol. But of the effects of various ſalts upon milk we elſewhere may, and therefore ſhall not now, diſcourſe.

BETWEEN this laſt recited experiment, and the two following ones, it will not be improper to inſert the immediately enſuing one, for the affinity, which it ſeems (in different reſpects) to have with both.

I REMEMBER then, that I divers years ago prepared a ſalt, which either was, or at leaſt anſwered well to the qualities aſcribed to that which is now called *Glauberus*'s *ſal mirabilis*, which ſeemed to have in it a coagulative power, in reference to common water. For whereas ſalt of tartar, common ſalt, nitre, *&c.* being diſſolved in water, do upon evaporation of a ſufficient quantity of that water, recover indeed their priſtine ſaline forms, yet they do but coagulate themſelves without concoagulating with them, either any water, or at leaſt ſo much, as chymiſts have thought worth the taking notice of. Whereas this ſalt we ſpeak of, being prepared for the purpoſe, and diſſolved in a convenient quantity of water, does upon its re-coagulation ſo diſpoſe of the aqueous particles, among its own ſaline ones, that if the experiment be well and carefully made, almoſt the whole mixture will ſhoot together into fine cryſtals, that ſeem to be of an uniform ſubſtance, and are conſiſtent enough to be even brittle, and to endure to be pulverized, ſifted, *&c.* though the concretion may have ſuch a proportion of water in it, that (as I remember) when the experiment ſucceeded well, from three parts of water, and but one of ſalt, I had about four parts of cryſtals.

I NEED not tell you, that this ſalt ſeems to have a ſomewhat more than ordinary reſemblance of a true coagulum, ſince it reduces ſo much water into a ſtable conſiſtence; yet it does in no contemptible proportion materially concur to the body produced. But I may hereafter (which I muſt not do now) entertain you about a ſalt of a differing kind from *this*; and which put me upon conſidering, whether there may not be a coagulum more properly ſo called of common water, which may in a very ſmall proportion operate upon a great quantity of that liquor, as runnet does on milk.

I HAVE not yet examined, whether it will be ſufficient to refer merely to the ſecond and third ways lately mentioned of making bodies become ſtable in the phænomena I am about to ſpeak of, or whether it may be reaſonably ſuppoſed (and added as a fifth way) that the bodies to be coagulated may (in great part) be brought to be ſo; by ſo acting upon the bodies to which they are put, that the agent liquor (if I may ſo ſpeak) does by its action communicate to the ſubject it works on, or loſe upon ſome other account ſome ſubtile parts whoſe abſence fits the diſpoſed remaining fluid for ſuch a coheſion, as may ſuffice to make a body be (though very ſoft, yet) conſiſtent. But however, it will not be amiſs to take ſome notice of effects, which, what e'er the cauſe be, belong to the *Hiſtory of Fluidity and Firmneſs*.

I SOME years ſince prepared a ſubſtance of a whitiſh colour, which would not only de-

ſtroy the fluidity of ſome other liquors, but would give a conſiſtency to a notable proportion of oil of vitriol it ſelf, though the parts of this liquor be preſumed, upon the ſcore of its corroſiveneſs, and its aptneſs to grow very hot with many other bodies, and make them ſmoke, to be very vehemently agitated.

AND I remember, that I ſometimes ſhewed the curious a glaſs phial well ſtopped, upon the bottom of which lay a little of this newly-mentioned whitiſh powder, over which there was a conſiderable proportion of oil of vitriol in a conſiſtent form, without ſeeming to have any thing to do with the powder, as indeed it had been only poured upon it, and ſuffered to ſtand in the cold for ſome time (which if I miſtake not was a day or two) at the end of which the above mentioned change was wrought on the liquor by the powder, which did not appear to be diſſolved thereby. Which phænomenon ſeemed indeed to argue, that there happened in this experiment (that was not the only one of the kind I then made) ſomething like the coagulation formerly mentioned of quickſilver by the vapour of lead; ſome ſubtile parts of the coagulator, if I may ſo call it, inviſibly pervading the liquor, whoſe fluidity was to be ſuſpended, though it ſeem not improbable to me, that the effect produced might depend upon both cauſes, this newly expreſſed, and the other a little above mentioned; where I gueſſed, that a change of texture, and thereby of conſiſtence in the menſtruum, might be the reſult of the operation of the menſtruum, and the body it acts upon. And becauſe this powder is not ſo eaſy to be prepared, I ſhall add, that you may (though not ſo well as by the newly-mentioned way) ſee the coagulation of a menſtruum upon a firm body, which it does not ſeem to diſſolve, by the enſuing experiment: Take cryſtals of ſaltpetre very well dried, but not powdered; and gently pouring on it in a glaſs phial ſome good oil of vitriol till it ſwim about half an inch, or perhaps more, above the ſalt; leave the phial cloſed with a cover of paper in a cool quiet place, where it may not be ſhaken: and if the trial ſucceed with you as did it with me, the liquor will, though ſlowly, ſo ſettle it ſelf about the nitre, that though you incline the phial to any ſide (or perhaps turn it upſide down) it will not run out: and I have ſometimes taken notice of little ſaline bodies, and as it were fibres, that ſeemed to keep the parts of the mixture united together. I made alſo ſome other trials to coagulate unflegmatick A. F. upon nitre and ſome other bodies, the phænomena of which trials did not oblige me to renounce the lately-mentioned conjectures about the cauſes of ſuch changes of conſiſtency in liquors, as I have been ſpeaking of: for I ſtill think it highly probable, that the beſt coagulator I have met with acts but as a finer ſort of runnet, which in an inconſiderable quantity really diſperſes material parts of it ſelf through the liquor to be wrought on, though theſe, when the coagulator is a conſiſtent body, be, perchance, ſo few or ſubtile, as not to make any viſible diminution of the body it parts with.

A MORE eminent example to our preſent purpoſe may be afforded us ſometimes, (for I am ſure the experiment will not always ſucceed) by the notable way of coagulating quickſilver, and thereby turning it from a fluid into a firm body, by the vapour of melted lead, in which when it is taken off the fire (but before it be quite grown hard again), a little cavity muſt be made with a pebble or a ſtick, that the quickſilver tied up in a rag may be nimbly put into that hole, and be congealed by the permeating ſteam of the cooling lead. Which effect may be leſs hopefully expected by the way wont to be preſcribed by authors (moſt of whom I doubt never made trial of it) than by another that I have practiſed, and may on another occaſion ſhew you. And that ſome metalline ſteam does really invade the quickſilver, ſeems probable by the waſting of lead by fuſion, and by the operations aſcribed by chymiſts to the fume of lead upon gold, about which I may elſewhere tell you what is come to my knowledge.

AND I remember, that not long ſince, an ingenious phyſician of my acquaintance keeping ſome lead long in fuſion to reduce it *per ſe* into a calx, and holding his head often over the melting pot to obſerve the alterations of the metal, was ſuddenly purged divers times both upwards and downwards, which both he and I aſcribed to the ſaturnine exhalations. And though I ſuſpected the congelation formerly mentioned might proceed from the egreſs of ſome ſubtile ſubſtance, that formerly agitated, but after deſerted, the mercurial corpuſcles; yet that the concretion of the quickſilver might be effected by ſome benumbing vapour of the lead, ſeems confirmable by a notable accident, that befel that famous geometrician Doctor *Wallis*, who related it to me as a phænomenon he knew not well what to make of; namely, that he and other learned men at *Oxford* being minded to make the experiment under conſideration, they found that, upon the firſt fuſion of the lead, the immerſed quickſilver was very well coagulated by it; but when they came to melt it the ſecond time, and put new quickſilver into it, the experiment would not ſucceed; at which they wondered, finding by trials, that the lead might be ſo eaſily deprived of its power of hardening quickſilver. That this obſervation will always hold true, I am not apt to believe; but that ſuch learned and candid naturaliſts ſhould either be miſtaken in making it, or miſrelate it, it were injurious to ſuſpect: wherefore ſuppoſing that to have then at leaſt happened, which one of them regiſtered in writing, and more than one of them told me; it ſeems to countenance what we have delivered, and looks as if, according to our doctrine, there were in lead a coagulative ſteam or ſpirit, and yet (at leaſt in that parcel of metal) in ſo ſmall a proportion, as that it almoſt totally diſlodges or ſpends it ſelf upon the firſt opportunity it meets with of paſſing into quickſilver.

WE have elſewhere, to another purpoſe, mentioned our having ſometimes (for, as we there advertiſe, it will not always ſucceed) made an experiment, which ſeems of kin to the former, and may give much light to the matter under con-

conſideration, and it was this; we poured upon aqua fortis common ſallet oil, which floated together at the top of it, but after ſome hours had its texture ſo changed by the aſcending ſteams or other ſubtile inſinuating particles of the ſaline liquor, that it was turned into a white conſiſtent (and ſometimes a brittle) body like butter, remaining all in one cake on the top of the menſtruum. And the like experiment (but in a longer time) we have performed with expreſs oil of ſweet almonds inſtead of common oil.

AND to ſhew further, how much the operation of the ſame viſible agent may be diverſified as to the production of fluidity or firmneſs, according to the differing diſpoſitions of the bodies it acts on; I have ſometimes (I remember) taken the ſame aqua fortis, or ſpirit of nitre, wherewith I had coagulated expreſſed oil of olives, and having poured it off from the butter-like ſubſtance; I caſt into it ſome good camphire, which, without heat, was thereby reduced into an oil, that retained a diſtinct ſuperficies from the menſtruum, which it ſwam upon, and would not incorporate with; ſo that the ſame numerical menſtruum, without the help of any degree of fire, turned a brittle body into a liquor, and the liquor into a brittle body, (for ſuch is the ſubſtance, that may be made of common oil, if it be ſuffered to float long enough upon the coagulating liquor;) which brittle ſubſtance (to add that upon the bye) ſeemed to have received a more durable alteration from the ſteams of the menſtruum than was expected. For not only when melted with fire, it would upon refrigeration recover its conſiſtence without becoming again fluid, as when it was in the form of oil; but I made a trial or two, without ſucceſs, to reduce it to a liquor, by mixing it with oil of tartar *per deliquium*, which, you know, has a great faculty to find out and mortify acid ſpirits, ſuch as thoſe of the nitre or aqua fortis, that had (whether as mere acids I now examine not) coagulated our oil.

THE fourth and laſt way, whereby corpuſcles entering from without into a body may give it a ſtable conſiſtence, is by making ſuch a commotion in the parts of it, as may make them apply themſelves one to another according to a greater ſurface, or otherwiſe complicate and diſpoſe them after the manner requiſite to make them ſtick together.

THIS way of making bodies become conſiſtent, is ſeldom or never employed by nature without the concurrence of ſome of the other ways already mentioned: but we have diſtinguiſhed it from the two laſt recited, becauſe in them we ſuppoſe, that ſome of the adventitious corpuſcles are ſtopped in the body, to whoſe firmneſs they conduce, and (though perhaps but in a very conſiderable proportion) do concur to make it up; whereas here we ſuppoſe, that without materially concurring to conſtitute the body they work upon, they do only agitate and variouſly move the particles it conſiſts of, perhaps breaking ſome, bending and twiſting others, and in a word ſo altering the texture, that the parts, that did formerly either move ſeparately, or adhere together but looſely, are now reduced to a cloſer order, or a more implicated texture, and thereby more firmly connected to one another. That the bare diſpoſition of the parts of a body in reference to each other, without any addition of foreign matter, may do much towards ſtability, we may ſee both in ſome examples formerly mentioned, and in oſier wands, which, when lying looſely in an heap together, may each of them very eaſily be diſſociated from the reſt; but when they are breeded into a baſket, they cohere ſo ſtrongly, that when you take up any one of them, you ſhall take up all the reſt. To which may be added thoſe many obvious, though perhaps unheeded, inſtances, wherein by the bare texture of the ſlender hair or filaments, whereof wool or ſilk conſiſts, cloth, ſilk-ſtockings, and many other durable garments are made by illiterate tradeſmen.

WE may alſo obſerve the force of bare motion in altering the texture, and thereby the conſiſtence of bodies by the common way of churning, for there the external impulſe of the churn makes a great commotion in the parts of the cream, and tumbles and ſhuffles them perpetually to and fro among themſelves; whereupon it happens, that the more branched corpuſcles meeting with one another, are intangled, and thereby ſeparated from the reſt, and after many occurſions all theſe parts are at length faſtened to one another, and excluding thoſe of the butter-milk, which ſeem not ſo conveniently ſhaped for mutual coheſion, do conſtitute butter: which is wont to be made yet more conſiſtent, or rather more compact, by being beaten or otherwiſe compreſſed, as the parts thereby reduced into a cloſer order ſqueeze out the fluid butter-milk, that was intercepted among them.

IT will perhaps be thought more ſtrange, that a fluid body, nay a diſtilled liquor, which is very volatile, and paſſes for ſimple and homogeneous, and is at leaſt far leſs compounded than milk, ſhould by motion, without the mixture of any new matter, be made coherent: and therefore I hope, that it will not only ſecond the example newly alledged, but likewiſe confirm ſome main points of our doctrine touching firmneſs, if we obſerve, that even the chymical oil of turpentine, which paſſes for one of the principles or elements of that body, may be in great part, if not wholly, coagulated without addition. And yet (not to anticipate what I may have occaſion to deliver elſewhere concerning this experiment) I ſhall now only relate, that inquiring a while ſince of a very expert chymiſt, whether he had not ſometimes obſerved (which I have often done, as I elſewhere declare) oil of turpentine to begin to coagulate, if it were often diſtilled; he went with me to his laboratory, and there let me ſee in a receiver ſome oil of turpentine, which he had often diſtilled over *per ſe*, in good part coagulated into a whitiſh and conſiſtent body: affirming alſo to me, that he had ſometimes, by frequent diſtillations, without addition, obtained from clear oil of turpentine a far greater proportion of ſuch a ſtable ſubſtance. Whoſe

con-

conſiſtence, whether it ſhould be aſcribed to the fire's breaking the oily corpuſcles into parts more fit for mutual coheſion, or whether it proceed from a new texture of the ſame corpuſcles, only chancing by thoſe various evolutions to be diſpoſed after ſuch another manner, as to complicate or otherwiſe connect them, I need not now ſpend time to inquire; ſince it is enough for my preſent purpoſe, that in this example we have one, that declares, how much even motion, without the addition of any ſenſible ſubſtance, may in ſome caſes conduce to firmneſs.

AND here to illuſtrate our doctrine about this quality and fluidity, by ſhewing what the inteſtine motion of the parts, even without the aſſiſtance of adventitious heat, may do, to make a body change its conſiſtence, according to the previous diſpoſition of the matter, and become of firm, fluid; as we lately ſaw oil of turpentine made of fluid, firm: I will add on this occaſion, what I obſerved of oil of wax diſtilled in a retort with an additament of the like nature with that I formerly mentioned, when I ſpoke of the fluid oil drawn from oil of olives. For this oil of wax, though at firſt it came over for the moſt part, if not totally, in the form of a butter; yet by ſtanding on a ſhelf (and that not in a hot place, as a ſtove or laboratory) I obſerved it little by little to reſolve into a tranſparent oil; and purpoſely inquiring of him, that looked after it, whether or no this effect might not be aſcribed to the increaſed warmth of the weather, he aſſured me of the contrary, having taken notice what effects the changes of weather had upon it.

BUT what if we ſhould ſay, that fluidneſs and ſtability depends ſo much upon the texture of the parts, that by the change of that texture the ſame parts may be made to conſtitute either a fluid or a dry body, and that permanently too? Theſe laſt words I add, becauſe of what may be ſaid to this purpoſe concerning the change of water into ice, and ice into water, and of metals into fluid or hard bodies, by fuſion and refrigeration: for in theſe examples the acquired hardneſs of water and fluidity of metals may be preſently loſt upon the bare removal of thoſe bodies into a temperate air; whereas in the inſtance we are to give, the acquired texture is ſo durable, that without an extreme external violence, ſuch as would deſtroy moſt other ſtable bodies, it is not to be deſtroyed. And this inſtance is afforded us by that admirable repoſitory of nature's wonders, quickſilver: for if ſome ounces of this fluid mineral be put into a convenient glaſs-veſſel, and that veſſel be firſt exactly ſtopped, and kept for ſix, eight, or ten weeks (or longer, if need be) in a ſand-furnace, whoſe heat may be ſtrong and conſtant, the corpuſcles, that conſtitute the quickſilver, will, after innumerable revolutions, and perhaps bendings, twiſtings, and other changes, be ſo connected to one another, that inſtead of a fluid body, they will appear in the form of a red powder, that chymiſts precipitate *per ſe*: which change is ſo unexampled, that though among the more curious Spagyriſts it be very well known, yet many Naturaliſts cannot eaſily be brought to believe it; whom to convince of the poſſibility of it by a much leſs tedious preparation, I take half a pound or a pound of quickſilver, and with a ſtrong fire diſtil it out of a glaſs-retort, and for the moſt part there will remain in the bottom and about the ſides of the veſſel a little red powder, which ſeems to be nothing but part of the fluid body (moſt expoſed to the action of the fire) turned into a dry one in eight or ten hours ſpace.

AFTER what manner the fire produces ſo odd a change in the quickſilver, I do not preſume to know. It is true, that though the parts of liquors do, as we have formerly taught, touch one another but in part of their ſuperficies, yet they all of them ſeem to have ſome degree of viſcoſity, or ſome ſlight and looſe complication or other kind of adheſion of parts, as appears by their being ſo eaſily contexed into thoſe thin membranes or films we call bubbles, inſomuch that not only ſpirit of wine, that ſeems the moſt light, and moſt fluid of liquors, will afford bubbles, but (what may ſeem ſtrange) we have divers times purpoſely obſerved, that quickſilver itſelf, as ponderous as it is, eſpecially being ſuffered to fall in a ſlender ſtream into a veſſel almoſt full of the ſame mineral, will afford bubbles numerous and large enough, although (as thoſe alſo of the ſpirit of wine) quickly vaniſhing.

AND hence it might be imagined, that in the operation we are treating of, ſome ſuch change is made in the quickſilver, as we formerly obſerved to be made in the white of an egg, when by a new diſpoſition of its parts, either heat or beating it makes it a kind of ſtable body, or elſe it might be pretended, that there is a variety of parts argued to be in quickſilver by the great variety of its effects upon other bodies, and that by the frequent evolutions, which the fire makes of thoſe parts among themſelves, they come at length to be ſo applied to one another, that either they lock into each other, as it were, or ſlip upon one another's ſurface in ſuch a manner, as that as much of their ſurfaces immediately touch one another, as is requiſite to make them cohere, as we formerly mentioned of ſeveral very ſmooth pieces of glaſs mutually adhering without any other cement, than the congruity and immediate contact of their ſurfaces. But though theſe conjectures and divers others might be propoſed, yet I fear all of them would prove but meer conjectures. Nor were we much aſſiſted to make better by looking upon our mercurial precipitate in one of the beſt magnifying glaſſes in the world; for what we there diſcovered was only, that the red powder had in it many corpuſcles of ſundry other colours, and that the little grains of powder ſeemed to be of no determinate ſhape, but looked like ſlender fragments of red-coral. And having put ſome ſmall duſt of a ſhining precipitate of gold and mercury into the ſame augmenting glaſs, all we could diſcern was, that the little grains of this precipitate differed from thoſe of that made of mercury alone, in that theſe (which a chymiſt would take notice of) were ſo tranſ-

parent throughout, that one would verily think he beheld the beſt ſort of thoſe precious ſtones goldſmiths call granats. But though we pretend not to make out, how the new texture is produced in the quickſilver, yet to make it ſtill more evident, that its change of conſiſtence proceeds from its change of texture, we will add, that having a great curioſity to try whether our powder could not be made fluid again, I procured ſome precipitate *per ſe* of a perſon, who formerly lived with me, and was expert in many mercurial operations, and preſented me ſome of his own making: this being weighed, and put into a convenient glaſs, was carefully preſſed with a naked fire (which ſhould be ſtronger than that wherewith it was precipitated) and at length it roſe by degrees in fumes, which ſettled in the neck of the glaſs in many drops of revived running mercury; all which being collected into one, we found, that there wanted but about a ſixth or ſeventh part of what we had put in, and we ſuppoſed we ſhould not have wanted that neither, but that the vehemence of the fire had melted the glaſs, which ſwallowed up a part of the powder, that made a great ſhew through it, after what was colliquated had been removed from the fire.

THIS experiment brings into my mind another, that was judged uncommon enough, and it was this: Being not long ſince maſter of about half an ounce of a certain mercury, which ſome ways of examining it, that I had employed, induced me to think mercury of Saturn; I imagined (for ſome reaſons) that it might be made very ſerviceable to confirm our doctrine touching fluidity and firmneſs. And accordingly I found upon trial, that I could, barely by ſhaking it long, reduce it to a black powder: in which form it would continue as long as I pleaſe to let it do ſo. And when to the byſtanders there appeared nothing in it, that gave ſuſpicion of a fluid body, I could in a trice, only by dexterouſly rubbing it in a ſmall marble mortar, reduce it little by little into running mercury, as it had been before. Which quick paſſage, from one quality to another, being made, not only without the help of fire, but without adding or taking away any viſible ſubſtance, proved no ignoble inſtance, how much motion and reſt, and the thence eaſily reſulting texture of the component corpuſcles of a portion of matter, may contribute to its fluidity or firmneſs.

FROM the experiment of precipitating quickſilver *per ſe*, and from ſome other things, partly delivered already, and partly to be delivered by and by, we may learn what to think of the opinion of ſome eminent modern philoſophers, who teach, that a fluid body is always diviſible into bodies equally fluid, as quantity into quantities, as if the particles of fluid bodies muſt alſo be fluid themſelves: for by them it ſeems to appear, that quickſilver, and ſome other actually fluid bodies conſiſt very much of hard corpuſcles, ſince by the change of their texture they may be deprived of their fluidity and become ſtable. We ſee alſo, that the ſtiff and ſolid particles of ſalts diſſolved in common water, and of ſilver diſſolved in aqua fortis, being by thoſe liquors ſufficiently diſſociated and ſeparately agitated, do with them conſtitute fluid bodies. And we have elſewhere mentioned to another purpoſe an experiment, which may not impertinently be repeated here; namely, that by putting together into a glaſs retort one part of quickſilver and four of common oil of vitriol, and diſtilling them in a ſand furnace with a ſtrong fire, there remain'd in the bottom of the veſſel a ponderous calx or powder, ſo far from being fluid, that it was but in part diſſoluble in water: and that, which ſeems to prove, that in the very liquid oil of vitriol, though a diſtilled liquor, the ſaline corpuſcles, that chiefly compoſe it, do retain their ſtiffneſs (generally to be found in undiſtilled ſalts) is, that by ſteeping our calx in fair water, we could ſeparate from it a conſiderable quantity of particles, which upon the evaporation of the water coagulated into ſtore of ſaline and brittle bodies. And that theſe proceeded rather from the menſtruum than the metal, we were induced to think, by obſerving the dry calx, before any water was poured on it: for though the ſaline part of the mixture did not weigh (perhaps any thing near) ſo much as the mercurial diſtinctly did, yet the aggregate or mixture did weigh a great deal more than the quickſilver did when it was put in; and the oil of vitriol, that was abſtracted, a great deal leſs, than it did before it was committed to diſtillation. Nay, I once or twice obſerved in a glaſs, where I kept a quantity of oil of vitriol, that there did ſpontaneouſly faſten themſelves to the ſides little ſaline cryſtals, which, when I took out, I found hard and brittle; but when I had, for trial-ſake, expoſed them to the air, they preſently reſumed a fluid form, and appeared to be oil of vitriol. In the obſervation alſo lately mentioned concerning the ſpontaneous coagulation of ſpirit of hartſhorn, it ſeems evident, that bodies, which are all or moſt of them hard, and appear ſo when they are commodiouſly connected to each other, may yet conſtitute a fluid body when they are reduced to ſufficient ſmallneſs, and put into a convenient motion. And indeed, if the leaſt particles of fluid bodies were not (many of them at leaſt) indowed with their determinate bigneſs and ſhapes, but that ſuch fluid bodies could be always divided into particles fluid alſo, how comes it to paſs, that ſome liquors cannot pierce into or moiſten ſome bodies, which are eaſily pervious to other liquors? For if the particles of the excluded liquor were of neceſſity always diviſible into fluid ones, there ſeems no reaſon, why they ſhould not be ſub-divided into ſo very ſmall ones, as that no pores can be ſuppoſed little or oddly figured enough to keep them out.

IT is true indeed, that as it is hard to demonſtrate, ſo it is not eaſy to diſprove, that the matter, whereof fluid bodies conſiſts, is capable of being indefinitely divided: and it may be granted too, that by how much the ſmaller parts a body is divided into, by ſo much the more eaſily, *cæteris paribus*, are the parts of that body to be put into motion. But this diviſibility

viſibility of a fluid body into perpetually leſſer and leſſer parts, belongs not to it properly as it is fluid, but as it is a body; ſuch diviſibility, if ſuppoſed true, being a primary affection of matter it ſelf, and belonging as well to thoſe portions of it that are hard, as to thoſe that are fluid. And though it were admitted, that ſuch an endleſs diviſion, as is preſumed might be made mentally, (as they ſpeak in the ſchools) that is, by the thought or operation of the mind, yet it would remain a great queſtion, whether or no nature does actually ſo far mince and ſubdivide bodies; as may appear by what has been freſhly noted. And however, it is not only requiſite to the conſtitution of a fluid body, that the parts of it be ſmall enough, but that they be alſo actually moved. For we obſerved, not long ſince, that the duſt of alabaſter put into motion did (though its corpuſcles were not inſenſible) emulate a fluid body, and immediately ceaſed to be fluid, when they ceaſed to be agitated: whereas the particles of water, as minute and apt as they are to conſtitute a fluid ſubſtance, do yet make that hard and brittle body we call ice, when thoſe little particles, upon what account ſoever, are reduced to be at reſt.

BY what has been hitherto diſcourſed, we may alſo be aſſiſted to judge of the doctrine of the chymiſts, who teach, that in all bodies, coagulation, ſtability, hardneſs, and brittleneſs depend upon ſalt: for though what above has been ſaid of curdling of milk by ſaline liquors, and the hardneſs and brittleneſs obvious in ſalts themſelves, may keep us from denying, that the ſaline principle is very powerful in the coagulation of ſome bodies, and does produce much firmneſs or even brittleneſs in many or moſt of the concretes wherein it is predominant; yet this hardening power of ſalt ſeems not to proceed from any peculiar and inexplicable property it has to coagulate other bodies, or make them compact, but from the ſhape and motion of its corpuſcles, which it ſeems are more fitted by nature, than thoſe of many other concretes, to inſinuate themſelves into the pores of other bodies, and faſten their particles to themſelves, and to one another, either by wedging their corpuſcles together, or by their ſtiff and ſlender parts, or their ſharp angles or edges piercing divers of them together; as when many pieces of paper are kept from ſcattering by a wire, that runs through them, or as when a knife takes up at once divers pieces of bread and meat, by being ſtuck into them all. But whenſoever there is in the conſtituent parts of the body a ſufficient fitneſs and diſpoſition to adhere firmly to one another, nature may of thoſe parts compoſe a ſtable body, whether they abound in ſalt or no; it not being ſo much upon chymical principles, or even upon the predominancy or plenty of any one ingredient, as upon the ſhape and motion of the component parts of bodies, that their fluidity and firmneſs depend. I will not here urge, that ſalts are generally reducible by an eaſy mixture with water into the form of liquors; nor that ſea-ſalt, ſalt of tartar, and divers other ſorts of ſalts, will of themſelves, even in the air, if not very dry, aſſume the form of fluid bodies; nor yet will I preſs the ſhortly to be mentioned example of coral, which is confidently affirmed to be ſoft, whilſt it remains in the ſalt water, and to grow hard when taken out of it: I will not here, I ſay, preſs theſe and the like arguments, but content my ſelf to have hinted them, becauſe they are ſuch, as I cannot well in few words make out and vindicate. Wherefore I ſhall rather demand, what ſalt can be made appear to paſs out of the body of melted lead into that of quickſilver, to perform in it the coagulation above mentioned? What acceſſion of ſalt is there to be obſerved, when running mercury is precipitated *per ſe* into a powder? And how will it be proved, that when in a well-ſtopped glaſs the whole body of water is, in froſty nights, turned into firm ice by the cold of the ambient air, that coagulation is performed by ſalt, it having not yet been made appear by chymiſts, that either ſalts or even the diſtilled ſpirits of them can penetrate, without a kind of prodigy, the narrow pores of unheated glaſs? It is uſually obſerved in eggs, that though at their firſt coming out of the hen's belly, the ſhells are ſoft, yet ſoon after they grow hard and brittle; and yet it appears not, how the ſaline ingredient is increaſed to effect this ſpeedy induration: and (to ſubjoin that by the by) albeit I am not averſe from thinking, that the coldneſs of the outward air, and its imbibing ſome of the looſeſt of the moiſt parts of the ſoft egg-ſhell, may concur to this effect; yet there are many obſervations of egg-ſhells, that have been found hard in the womb of the hen. And I well remember I have taken notice, that divers eggs not yet laid, but found at one time in the body of the ſame hen, were each of them furniſhed with a compleat and brittle ſhell. But I think I can draw a much ſtronger argument againſt the chymical opinion from the conſideration of an egg; for I demand, what plenty of ſalt can be made appear to pierce the hard ſhell, and more cloſe-wrought membrane, that both lines it and involves the egg, eſpecially ſince it is certain, that in *Egypt*, and divers other places, eggs may be hatched by a temperate external heat without the hen. And yet we may here obſerve, that the ſame internal ſubſtance of the egg, which at firſt was fluid, the yolk and white, that compoſed it, being ſo, is upon the excluſion of the chick turned almoſt all of it into conſiſtent bodies, ſome of them tough, as the membranes and griſtles of the bird, and ſome of them harder and almoſt brittle, as his bones and beak; and all this, as we ſaid, without acceſſion of new ſalt. It would be hard for chymiſts to prove, that diamonds and rubies, which are counted the hardeſt bodies we know, (and at particular trials of whoſe hardneſs I have ſometimes wondered) do abound in ſalt; at leaſt it will not be unreaſonable for us to think ſo, till chymiſts have taught us intelligible and practicable ways of ſeparating (at leaſt ſome) true ſalt from either of thoſe jewels. And it may be alſo doubted, whether the blood of animals, when it is freeſt from ſerum, do not (though a liquor)

as much abound with ſalt as their ſkins or their fleſh.

AND ſince it is with chymiſts that I am now reaſoning, I preſume I may be allowed to preſs them with arguments drawn from ſome of the eminenteſt writers of their ſect. For the generality of chymiſts, and even thoſe, that are by the reſt, and themſelves too, called philoſophers, not only granting, but aſſerting and maintaining the tranſmutation of great quantities of quickſilver and the other ignobler metals into ſilver or gold by means of the white or red elixir, I ſhall demand of them, whence it happens, that one grain of the powder of projection can turn a whole pound of mercury into true gold or ſilver, and conſequently change a very fluid body into a very firm one; though the proportion of ſalt employed to coagulate the whole maſs of quickſilver would not amount to the ſix thouſandth or ſeven thouſandth part of the liquor; though we ſhould grant, that the powder employed to work this marvellous change were all of it ſalt, to which yet chymical writers aſcribe much more of the ſulphurous nature. And to this I ſhall add, what the famous and acute *Helmont* does to another purpoſe relate upon the experience of *Raymund Lully* and his own, concerning his prodigious liquor, alkaheſt; namely, that being abſtracted from common quickſilver, it does in a quarter of an hour coagulate it: and yet in this coagulation he points at this as a ſingular phænomenon, that this liquor, which is as well immortal as exceeding ſaline, leaves nothing of itſelf with the mercury, on which it works, and yet ſo coagulates it, that he preſcribes the making it into a ſubtile powder.

Helmont de Febr. cap. 14.

I REMEMBER alſo to our preſent purpoſe, that a phyſician of much veracity in what he relates, diſcourſing with me the other day about an odd preparation, that he ſaw at the preſent Duke of *Holſtein*'s, (that learned prince and great chymiſt) aſſured me, that among other things he there took notice of a glaſs of ſpirit of urine, which in warm weather remained in the form of a liquor, but in cold weather did totally coagulate into cryſtalline ſalt. And being aſked by me, if he knew how this urinous body had been prepared? he anſwered me, that the Duke cauſed ſpirit of urine exceeding rich in volatile ſalt to be diſtilled very many times; after every diſtillation re-conjoining all, that came over in a liquid with that, which remained in a ſaline form, till by very frequent cohobations all the parts of the urinous ſubſtance were brought to the union or coalition abovementioned. What we may propoſe concerning the various conſiſtence of the ſaline part of urine upon our own knowledge, we ſhall for certain reaſons reſerve for another place.

AND on this occaſion we will annex a few particulars, which may tend not only to the making of the chymical hypotheſis about the coagulation of bodies doubtful, but to the confirmation of much of the doctrine by us propoſed. The firſt ſhall be an obſervation afforded us by the art of making ſugar, wherein very great care is taken, that nothing acid (and eſpecially juice of lemons) fall into the chaldrons or other veſſels, wherein the juice of the ſugar-cane is to coagulate into ſugar: for though acidity be generally by the chymiſts aſcribed to ſalt, yet here the ſaline bodies are ſo far from promoting the coagulation of the ſaccharine ſyrup, that they would quite hinder it. And becauſe that through the want of ſugar-canes in theſe parts, we are reduced to take this obſervation upon the credit of others, and becauſe alſo in itſelf it ſeem ſomewhat ſtrange, we will vouch for it two eminent authors, in whoſe writings we met with it. The one is the ingenious French publiſher of the natural and moral hiſtory of thoſe American iſlands, commonly called by the French *les Iſles Antilles*, and by us the Caribbee iſlands; who deſcribing particularly how his country-men make ſugar in thoſe parts, gives this caution towards the latter end, *Sur tout*, &c. that is, above all, great heed muſt be taken, to let no juice of citrons (or lemons) fall into the caldrons, for that would abſolutely hinder the formation of the ſugar. The other is the diligent *Gulielmus Piſo*, who having given us a particular account, both by words and pictures, of the way of making ſugar, tells us that, *ſi momentum ſucci limonis vel acidi quid injiciatur, ſacchari conſiſtentiam nunquam acquiret, ſed in totum perditur.* To which I ſhall add, that having purpoſely inquired concerning this obſervation, it has been confirmed unto me by perſons, that pretend more than ordinary knowledge of the art of ordering ſugar: which likewiſe affords us another obſervation not impertinent to the theme we treat of; for the beſt authors, that write hereof, inform us, that the juice ſqueezed out of the ſugar-canes is wont firſt to be boiled and depurated in vaſt veſſels of copper or braſs, whence it afterwards is conveyed to be further purified and coagulated into ſmaller ones; and that whilſt it is in the former, they uſe to pour upon it ſome very ſtrong lee to facilitate the ſeparation of its feculencies, as in the ſmaller ones it is uſual to pour a little oil or butter upon the boiling juice, to keep the ſyrup from boiling over. Now that, which they further obſerve to our purpoſe, is related almoſt after the ſame manner both by our French author and by *Piſo*, and by the latter of them in theſe words: *obſervatu dignum* (ſays he) *ſi oleum majoribus inderetur ahenis in quibus liquor primus, caldo dictus, purificatur, ſaccharo conficiendo plane foret ineptus: viciſſim ſi minoribus lixivium ſicut majoribus infundatur, æquè impoſſibile ſaccharum conficere.* So much the fluidity and firmneſs of bodies depend upon their texture, how much ſoever chymiſts would have them depend upon ſalt.

Hiſt. Moral. Cap. 5.

Hiſto. Nat. & Med. Braſil. l. 4. c. 1.

Gulielm. Piſo, & Author Gallic. ubi ſupra.

BUT to this borrowed obſervation, though borrowed of authors not to be diſtruſted, we will add two or three experiments of our own, which we hope may the more confirm the doctrine by us propoſed touching ſtability in bodies, becauſe it was our aim in them to bring light by them to the matters we treat of.

FIRST then, we prepared a liquor, elſewhere to be deſcribed, which is almoſt, if not altogether, as ſaline as *aqua fortis* itſelf, or any other

acid ſpirit, that is commonly known: and yet when in this liquor we laid fragments of ſolid harts-horn of ſeveral ſizes to ſteep, even in a cold place, the menſtruum was ſo far from hardening them, that it would (without diſſolving them as corroſive liquors do metals) gently pierce into them and ſoften them; ſo that in about two or three days it would reduce them to a kind of white ſlime, or mucilaginous ſubſtance, at the bottom of the liquor. We took alſo good ſalt of tartar, and on it poured good ſpirit of vinegar, as long as the affuſion of it would produce any ebullition: then we diſtilled off the liquor, which came over almoſt inſipid, the ſaline parts, that make ſpirit of vinegar ſo ſharp, being retained by the ſalt of tartar. Upon the remaining dry mixture we poured freſh ſpirit of vinegar, as long as any hiſſing enſued thereupon, and afterwards abſtracted the aqueous parts of this parcell of liquor alſo; and ſo we proceeded, till having ſufficiently impregnated the fixed ſalt with the ſaline parts of the diſtilled vinegar, we obtained, according to our deſire, a mixture, which (though it were all made up of ſalts, and ſuch ſalts too as being made by the chymical analyſis of the bodies whence they were drawn, may according to the chymical doctrine be looked upon as pure and elementary) was yet ſo near fluidity, that it required not the heat of the fire to turn it preſently into a liquor, which ſhape it aſſumed with a gentler warmth, than one would expect from a ſaline body. Laſtly, we took common oil of vitriol, and caſt into it divers little pieces of camphire, which floating upon it were by degrees and after ſome hours wholly reduced into a reddiſh oil, that was to be ſeen altogether upon the top of the other liquor. Then having formerly tried that oil of vitriol would eaſily mix with common oil, we tried alſo, by ſhaking the ſaline and camphorate liquors together, to unite them, and eaſily confounded them into one high-coloured liquor, which ſeemed very uniform, and continued ſo (at leaſt as to ſenſe) for many hours. Then we added to this mixture three or four times as much fair water, and (as we expected) the camphire immediately recovered a white conſiſtent body, and by degrees ſettled at the top of the liquor: where we may obſerve, that the camphire is not made hard but fluid by its mixture with the ſaline corpuſcles of oil of vitriol, and exchanges its fluidity for firmneſs upon the affuſion of ſaltleſs water. And thus much it may ſuffice to have ſaid touching the chymiſts deriving the ſtability of bodies from their abounding in ſalt.

AND as for the hardneſs and brittleneſs they aſcribe to the ſame principle, how much they may be increaſed or diminiſhed in a body, without the acceſſion or decrement of the ſaline principle or ingredient, may appear by that experiment mentioned by us to ſeveral purpoſes, of tempering a ſlender piece of ſteel: for when it has been ſufficiently heated, by plunging it red-hot into fair water, which is more likely to diſſolve than increaſe its ſalt, you may make it not very hard alone, but very brittle; whereas by only ſuffering it to cool leiſurely in the air, it will be both much leſs hard and more tough. And if after having quenched it in cold water, you again heat it till it have attained a deep blue, it will become (comparatively) ſoft and very flexible, and that not from any waſting of the ſaline ingredient by the fire; for if this ſoftened ſteel be again heated red hot, and ſuddenly refrigerated, whether in water or otherwiſe, as before, it will re-acquire both hardneſs and brittleneſs.

NOW that by theſe operations a real change is made in the diſpoſition of the ſmall parts of the ſteel, we have elſewhere evinced even by a ſenſible proof. And that by procuring a cloſer order and more immediate contact of the parts of a body, a man may without increaſing the ſalt increaſe the hardneſs of it, is, as we formerly alſo noted, obvious in ſnow, which whilſt it lies in flakes as it falls upon the ground, compoſes but a ſoft and yielding body; but when the ſame ſnow is, by being ſtrongly preſſed every way betwixt the hands, formed into balls, the little whether icicles or frozen bubbles it conſiſts of, are ſo approached to one another, and forced into an order, which allows ſo little waſte of room, that the formerly-intercepted ſpaces being moſt of them filled up with little bodies, the icicles can no longer yield, as they did before, to the preſſure of a man's fingers, but conſtitute a maſs conſiderably hard, which yet may be made harder being melted into water, and afterwards frozen into ice: for this having been a fluid body, (and in ſuch, room is wont to be better huſbanded than in others) the bubbles intercepted in it cannot keep it from being of ſo cloſe a texture, as to be conſiderably hard.

I KNOW, that not only profeſt chymiſts, but other perſons, who are deſervedly ranked amongſt the modern philoſophers, do with much confidence entirely aſcribe the induration, and eſpecially the lapideſcence of bodies, to a certain ſecret internal principle, by ſome of them called a form, and by others a petrifying ſpirit, lurking for the moſt part in ſome liquid vehicle. And for my part, having had the opportunity to be in a place, where I could in a dry mould and a very elevated piece of ground cauſe to be digged out ſeveral cryſtalline bodies, whoſe ſmooth ſides and angles were as exquiſitely figured, as if they had been wrought by a ſkilful artiſt at cutting of precious ſtones, and having alſo had the opportunity to conſider divers other exactly or regularly ſhaped ſtones and other minerals, ſome digged out of the earth by my friends, and ſome yet growing upon ſtones newly torn from the rock; I am very forward to grant, that (as I elſewhere intimate) it is a plaſtick principle implanted by the moſt wiſe creator in certain parcels of matter, that does produce in ſuch concretions as well the hard conſiſtence as the determinate figure. We deny not then, that theſe effects depend moſt commonly upon an internal principle; but the difficulty conſiſts in conceiving, how that internal principle produces its effects, which theſe writers not pretending to explicate intelligibly, we thought it not amiſs briefly to ſurvey ſome of the principal ways, by which

which it ſeems, that nature makes bodies firm and ſtable, whereby we may be aſſiſted to judge, whether it be as neceſſary to have recourſe to a plaſtick principle or a Gorgonick ſpirit in all other quick and notable indurations of bodies in the cold, as in the hardening ſuch bodies, whoſe curious and determinate either internal textures or outward ſhapes (common to ſeveral concretions of one kind) argue their having been framed by ſome one formative power, or by divers ſeminal principles convened together. But this we will do without affirming, either that ſhe cannot by ſome other yet unobſerved way make conſiſtent bodies, or that of the ways by us diſcourſed of, ſhe is wont ſo to confine her ſelf to any one, that ſhe does not frequently make uſe of two or more of them, to produce the ſame effect.

AND becauſe hardneſs is a high degree of firmneſs, I ſuppoſe it will not be impertinent to ſhew by ſome examples, how ſmall an external operation may, without any appearing adventitious ſalt, make a ſoft body hard, and even brittle, when there appears not any other change to be made, than that of the texture or diſpoſition of its component particles.

IT is a tradition amongſt naturaliſts, that coral grows ſoft at the bottom of the ſea, but when it is brought up into the open air, though it retains its bulk and figure, it hardens into a ſtony concretion, according to that of *Ovid*:

Ovid. 15. *Metamor.*

Sic & coralium, quo primum contigit auras
Tempore dureſcit, mollis fuit herba ſub undis.

WHETHER or no this tradition is ſtrictly true, we had not opportunity, when we ſtaid at *Marſeilles* (whoſe neighbouring ſea is the chiefeſt in *Europe* where coral is wont to be fiſhed) to give our ſelves an ocular ſatisfaction. But whatever ſome ſay to diſcredit the tradition, nay, how confidently ſoever *Beguinus* (who ſeems to have the moſt ſtrongly argued againſt it,) hath rejected it, it muſt not be denied to be, ſometimes at leaſt, true, (and that is enough to ſerve our preſent turn.) For the learned *Gaſſendus* in the life of *Pereſkius*, relating how that incomparable gentleman had the curioſity to fiſh for coral near *Toulon*, (a noble port not far from *Marſeilles*) has among other things this paſſage: (*viz.*) The plants, which were plucked up and drawn out were neither red nor handſome till their bark was pulled off; in ſome parts they were ſoft, and would give way to the hand, as towards the tops, which being broken and ſqueezed, they ſent forth milk, like that of figs. I remember likewiſe, that the learned Jeſuit *Fournier*, who being alſo a French hydrographer, and one that writes of *Marſeilles* and *Toulon* as places very well known unto him, may be ſafely credited on this occaſion; after he has particularly deſcribed the way of fiſhing corals near *Toulon*, he adds; Theſe plants are neither red nor poliſhed, when they are drawn out of the water, till their rind have been taken off; nay, they are ſoft, and being broken or elſe ſqueezed betwixt the fingers, they throw out a kind of milk reſembling that of figs; and when one leaves off preſſing them, he may ſee the ſmall holes or pores, that harboured the milk, that was ſqueezed out. Thus far he. The credibleneſs of a good part of theſe narratives has been confirmed to me by a practiſer of phyſick in the *Eaſt-Indies*, who having made ſome ſtay at his return on the iſland of *Mehila* (near that of *Madagaſcar*) where ſtore of white coral is reported to grow, I inquired of him, whether he had gathered any, and whether he found it ſoft whilſt it was growing? and he anſwered me, that he had of late years divers times gathered coral upon the ſands of that iſland; and found it, when he gathered it, exceeding white, and (to uſe his expreſſion) as ſoft as an onion: adding, that though it would in a very ſhort time grow hard in the air, (which he aſcribed, how juſtly I know not, to the external heat of the ſun) yet it is very well known to the ſea-men, that deal in that ware, that if it be not gathered at a ſeaſonable time of the year, it will not keep long, but either crumble away or otherwiſe decay: which diſagrees not with the experienced *Piſo*, who in his natural hiſtory of *Braſil*, ſpeaking of ſome places of the *Braſilian* coaſt, where divers ſtony plants, ſome like little trees, ſome otherwiſe framed, may be ſeen in clear weather growing in the bottom of the ſea, tells us, that, *è fundo erutæ mox duriſſimæ, ſi inſolentur in littore, ſiccæ niveique coloris fiunt.* As remarkable a change is that I meet with in *Scaliger*, who tells us, as upon his own knowledge, of ſome, who at the urinary paſſages voided a ſlimy matter, which in the air coagulated into a firm ſubſtance. The ſtory being memorable, take it in his own words thus: *Ex bovillis oppidanus noſtris adjutus medicamentis eminxit vitrum ſane ex illa nobili Paxagoræ pituita, dum mingeretur albuminis mollitie emiſſum vitri duritie ac ſplendore, ſenatoris filius ejecit, puttis modo multos, & maximos: qui aëris contactu poſtea in gypſeam tum ſpeciem tum firmitatem concrevere; hic quoque nunc rectè valet.* Having likewiſe had the acquaintance of an inquiſitive merchant of *Dantzick*, and alſo of an ingenious chymiſt, that ſpent ſome time in that city and the neighbouring country, along whoſe coaſt our European amber is wont to be dragged out of the ſea; I inquired of them, whether they had never obſerved in amber a property like that which is reported of coral: and one of them, as I remember the other alſo, hath aſſured me upon his own particular obſervation, that lumps of amber are ſometimes taken ſoft out of the ſea, and grow hard in the air; which is the more credible to me, becauſe I have at a *Polonian* noble-man's ſeen (beſides other intercepted things) a whole ſpider, and that none of the leaſt, perfectly incloſed in a piece of hard and tranſparent yellow amber. And elſewhere I have ſeen ten or twelve (if I miſ-remember not the number) pieces of ſuch amber, which contained, one a fly, another a ſpider, a third a ſtraw, and each of the reſt ſome ſuch other thing. And it ſeems not impoſſible, that the contact of the external air may put the parts of ſuch ſmall bodies into a new motion, whereby ſome voluble corpuſcles, that hinder their reciprocal adheſion, may be excluded, and the

Beguin. Tyrocin. Chym. Lib. 2. Cap. 10.

Lib. 4. *Anno Domini* 1624.

Hydrogra. de P. Fournier. Lib. 4. Cap. 27.

Lib. 4. Cap. 68.

particles

particles themſelves preſſed or otherwiſe diſpoſed into a cloſer order. And we find, that ſome oil-colours, after they are brought to their due temper, may be preſerved very long in the ſame degree of ſoftneſs, if they and the ſhells, that contain them, be kept all the while under water, whereas in the air they would quickly change their texture, and become dry and hard.

BUT though in this laſt mentioned example, and ſome others, the removal of the body out of the water into the air ſeem manifeſtly to contribute to its growing hard, yet it ſeems not to us ſo eaſy to determine, what ſhare the air has in effecting ſuch indurations: for *Gaſſendus* relates of *Pierеſkius*, that he being wont in the ſummer time to waſh himſelf in one of the leſſer ſtreams of the river of *Rhône*, he there made the following obſervation. Once upon a time he felt the ground, which he had wont to find even and ſoft, to be grown hard with little round balls or bunches, like hard boiled eggs, when the ſhell is peeled off; at which wondering, he took ſome of them up, and carried them home, that he might ſhew them to his maſter, and demand of him the reaſon. But the miracle was increaſed, when a few days after returning to the river, he found thoſe litttle balls or lumps turned into perfect pebble ſtones, which he obſerved likewiſe to befall thoſe, which he had carried and laid up at home. But how far this ſtory will prove, that ſuch coagulations muſt be effected by a ſubſtantial form of a petrifying liquor, we define not; eſpecially ſince, not to repeat what we delivered already touching calcined marble out of *Fournier*, we have elſewhere delivered upon our own obſervation, that two or three ſpoonfuls of ſuch pap of burnt alabaſter, as we have lately been ſpeaking of, (and inſtead of which artificers uſe another ſtone called by them plaiſter of *Paris*, burnt and tempered up with fair water) did in the bottom of a veſſel-full of water, into which we poured it, in a ſhort time coagulate into a hard lump, notwithſtanding the water, that ſurrounded it; which, it ſeems, by the texture of the maſs, was kept out of its pores, as it is out of thoſe of the oils of cinnamon and cloves, which, though fluid bodies, and ſinking in water, ſuffer not its particles to inſinuate themſelves into theirs: and artificers obſerve, that the coagulating property of burnt alabaſter will be very much impaired, if not loſt, if the powder be kept too long, eſpecially in the open air, before it be made uſe of; and when it has been once tempered with water, and ſuffered to grow hard, they tell me they cannot by any burning or powdering of it again make it near ſo ſerviceable for their purpoſe as before; ſo much doth the coagulation of theſe powders mixed with water ſeem to depend upon their texture and other mechanical qualities.

Gaſſend. in vita Pireskii, Lib. 1.

I REMEMBER alſo, that though the bones found in the hearts of deer, and ſo magnified by phyſicians, do, in the air, acquire a hard and bony conſiſtence; yet having had the curioſity to conſider one of them in the heart of a deer newly killed, I found it there of a cartilaginous ſoftneſs and flexibility.

AND here I will adventure further to confeſs, that I have oftentimes doubted, whether or no, not only conſiſtent bodies, but ſome of the moſt ſolid ones in the world, may not have been fluid in the form either of ſteams or liquors, before their coalition and their concretion either into ſtones or other mineral bodies. I know there are many, who think, that ſtones, marchaſites, and other ſuch ſolid and durable bodies, were made together at the creation or other beginning of the univerſe, and who will not admit, that ſuch concretions can be now generated. But not here to debate that famous controverſy, whether ſtones may be ſaid to grow and to be nouriſhed, in the ſtrict ſenſe of thoſe expreſſions, I think it not difficult to ſhew, that ſuch parcels of matter are now to be met with in the form of ſtones, as did not before appear under that form; but whilſt it was divided into minute parts, either was it ſelf ſome fluid body or other, or at leaſt did as a material part concur to the conſtituting of one, that was ſo. Of this, beſides what we elſewhere deliver concerning it, we ſhall anon have occaſion to mention ſome proofs; and therefore we ſhall now only mention two or three inſtances. The firſt whereof ſhall be, that we ſaw, among the rarities of a perſon exceedingly curious of them, a ſtone flat on the outſides; on one of whoſe internal ſurfaces was moſt lively engraven the figure of a ſmall fiſh, with all the fins, ſcales, *&c.* which was affirmed to have been incloſed in the body of that ſtone, and to have been accidentally diſcovered, when the ſtone chancing to receive a rude knock upon its edge, ſplit aſunder. I remember alſo, that a while ſince a houſe-keeper of mine in the country informed me, that whilſt a little before he cauſed in my abſence one of my walls to be repaired, the maſon I was wont to employ caſually breaking a ſtone to make uſe of it about the building, found in it (to his wonder) a piece of wood, that ſeemed part of the branch of ſome tree, and conſequently afterwards incloſed with that ſolid caſe, wherein he found it. This cavity in the body of the ſtone, and, as I remember, the ſtick itſelf he took out of it, he forthwith brought my houſe-keeper, to whom I have given directions to ſend them me. For this example ſeems to me a more cogent proof of the increaſe of ſtones, than ſome others, that eminent naturaliſts much rely on, for reaſons diſcourſed of in another place*: where we alſo make particular mention of that ghur or metalline juice, which though the Latin writers of chymical, and even of metalline, matters have not, that I remember, given us any account of, yet I find a German or two, that were very converſant in the mines themſelves, to have in books written in their own language taken a ſpecial notice of it. Beſides, I have at preſent ſomething to deliver upon my own obſervation, which, unleſs we will ſuppoſe (what ſeems not probable) that there were from the beginning made together with and in the midſt

* In ſome of the Author's papers about the origin of minerals.

of great maſſes of one kind of mineral little parcels of another of a quite differing ſort, ſeems manifeſtly enough to argue, that either whole quarries of ſtone, or heavy and ſhining minerals, or both, may have been fluid bodies. The obſervation, whereon I ground this conjecture, is, not only, that we have met with in lead-ore, and alſo in *Minera Antimonii* particles of a white ſtone or ſpar environed with a metalline body, though I think I have yet by me ſuch lumps of ore; but chiefly, that I have, with my own hands, taken a hard and ponderous ſhining mineral, which I keep for a rarity, like a marchaſite, of the ſhape of a pear, and of about the bigneſs of a walnut, out of the very body of a ſtone, wherein I ſuſpected it to be incloſed, and which environed it on all ſides: and this I took not out of a ſmall and looſe ſtone, but a large ſtone digged out to make ſtatues of. And I remember, that one of thoſe, that wrought upon it, told me, that in faſhioning it into ſtatues they found ſome more minerals in the ſame parcel of ſtone, which were alſo preſented me. To which I ſhall add, that an ingenious ſtatuary having in another place taken much pains to ſaw aſunder a very large ſtone, when he came to the midſt of it, found he could ſaw on no further, and the ſtone being afterwards broken, he perceived, that that, which ſo obſtinately reſiſted his ſaws, was a round marchaſite, which he brought to me, as a lover of ſuch curioſities. But I made him for my further ſatisfaction bring me alſo that part of the ſtone, wherein the marchaſite ſtuck, and by comparing them together diſcerned, that as much of the ſtone, as was contiguous to the marchaſite, had a kind of ruſt about it, and fitted the marchaſite ſo cloſe, as if either the marchaſite had been formerly liquid, and had afterwards been as it were moulded in that receptacle, or the ſtone had been formerly of ſome ſoft or fluid matter, which did exactly accommodate it ſelf to the ſhape of the other body; or elſe, as if both the matter of the ſtone and that of the marchaſite had been at once fluid bodies, but had each of them preſerved its own ſurface diſtinct (according to what we formerly noted of differing fluids) till one of them (probably the marchaſite) firſt growing hard, the other, as being yet of a more yielding conſiſtence, accommodated it ſelf to the harder's figure.

BUT the moſt eminent inſtances to declare, how much the fluidity and firmneſs of bodies depend upon the contrivance and texture of their parts, are afforded us by thoſe waters, which being permitted to reſt a while, do ſpontaneouſly ceaſe to be fluid, and coagulate into ſtone it ſelf. There was lately an ingenious man, who going to viſit ſome leaden mines, wherein he had a ſhare, found in the mountain, in whoſe entrails they were hid, a cave, from whoſe arched roof there dropped down a petreſcent liquor, which oftentimes before it could fall to the ground congealed, and by appoſition of like matter increaſed ſo much, that they hung from the roof like icicles in a froſty-night from the ſides of a houſe; and of theſe he gathered and brought me divers, which are perfect ſtones hard and brittle, and of eight or ten inches long, and proportionably thick. Another ingenious friend of mine being lately in *France*, in the cave ſo famous for petrifying liquor to be there ſeen, obſerving ſome drops of water to congeal into ſtone, whilſt he ſtood by, took them away with him, and ſent them me in a letter. Nay, we ſhall ſcarce deny, that an external agent of almoſt inſenſible bulk may turn animal bodies into ſtony ones, by introducing a new texture into their parts, if we will, with ſome modern writers, believe *Aventinus*, who in his *Bavarian Hiſtory* has recorded, that at a time and place by him ſpecified, above forty countrymen, as alſo ſome milk-maids with their cows killed upon an earthquake, had their bodies by a terrene ſpirit turned into ſtatues, which, he ſays, were ſeen by the chancellor of *Auſtria* and himſelf. And ſome relations of this nature we meet with in other authors, which, if they be allowed of, ſeem much to confirm our doctrine; for in theſe ſtrange petrifications, the hardening of the bodies ſeems to be effected principally, if not only, as in the induration of the fluid ſubſtances of an egg into a chick, by altering the diſpoſition of their parts, ſince the petrifying wind or ſteam cannot be ſuppoſed to have any ſuch conſiderable (perhaps not any ſenſible) proportion as to bulk to the body changed by it, as to be thought to effect this change principally as an ingredient.

ADD we to all theſe things, that *Pamphilio Piacentino* is by another author quoted for writing an unparallelled ſtory, which becauſe written in Italian, I ſhall Engliſh the ſubſtance of it, which is this: 'That a woman in *Venice*, 'after having eaten an apple, was taken with 'hideous tortures, and in the ſpace of twenty-'four hours dying, was turned into exceeding 'hard ſtone; and this was judged to be the ef-'fect of the poiſoned apple ſhe had eaten.' Which narrative, if we may believe it as confidently as the famous alledger of it *Pamphilio* appears to do, would ſeem to argue, that even to the wonderful induration of bodies there is ſometimes no other principle requiſite, than what may reſult from the lucky mixture of the parts of ſeveral bodies. And leſt we ſhould ſeem to build altogether upon the obſervations of others, which cannot by us be now brought to ſtrict examination, we will have recourſe to a practicable experiment of our own trying, which, though we have elſewhere mentioned, we ſhall not ſcruple here to repeat, becauſe we there omitted to ſpeak of that circumſtance of it, which is the moſt pertinent to our preſent deſign.

TAKE then two ounces of quickſilver, two ounces and a half of the beſt verdigreaſe, about half an ounce or an ounce of common ſalt, a pint or pound of white-wine vinegar, and as much fair water; mingle the verdigreaſe, quickſilver, and the ſalt very well, and put the mixture with a little of the vinegar and water into a new frying-pan, (I tried it in a new earthen veſſel, but without good ſucceſs) in which fry it over the fire for divers hours, keeping it continually ſtirred, and putting in more vinegar

gar and water from time to time, as that already put in conſumes away: then take out the mixture, and in ſeveral clean waters waſh it carefully from the adhering ſalts; then dry away all the aqueous moiſture with a clean linen cloth, and you ſhall have a bright amalgama almoſt like quickſilver. Now that which is remarkable and to our preſent purpoſe in this experiment, is, that though this dried mixture be a good while after it is perfectly cold not only ſoft, but ſo near to fluid, that I have caſt it into moulds, and made imboſſed images of it, (when it has been dexterouſly made, but ſcarce otherwiſe;) I have found, that by laying it a few hours in the air, which ſeemed leſs cold than it ſelf, it has acquired ſuch a hardneſs, that being thrown againſt the floor it would rebound, and was brittle like overhardened ſteel. And yet in this example the induration of the amalgam appears not to proceed from an innate and inward principle, but from the new texture reſulting from the coalition of the mingled ingredients, that make up the amalgam, whoſe parts being variouſly moved, partly by the fire (and, perhaps too, by the ſalts) and partly by the native propenſity to motion of the mercurial corpuſcles, were by little and little, or by degrees, ſo diſpoſed, that whereas before touching one another but looſely, it was eaſy to thruſt ſome of them towards the middle of the body, without ſtirring much of the maſs (as to ſenſe) by this change of texture, the particles are brought to touch one another more cloſely and in greater portions of their ſurfaces, and to be ſo complicated, intangled, or otherwiſe connected among themſelves, that you cannot endeavour to thruſt one of them out of its place, but that its motion ſhall be reſiſted by many others, to whom it is ſo faſtened, that you cannot move one part of the maſs without either moving the whole with it, or manifeſtly breaking it off from the whole, and thereby deſtroying the continuity and unity of the body.

Now whereas, in ſetting down this experiment, we ſpoke as if ſeveral ingredients did concur to conſtitute the ſoft maſs, which afterwards grew ſo hard, we might very ſafely do ſo, ſince the quickſilver was not ſo barely changed in texture, as that formerly ſaid to have been coagulated by the meer fume of lead, but concealed in its ſelf a great number of metalline corpuſcles beſides others, as we made appear by ſeparating from the amalgam, meerly by the force of fire, a pretty quantity of true and perfect copper. That the ſalts alſo both were ingredients (though in ſmall proportion) of the maſs, and might have ſome operation upon the other particles, we may render probable by this, that having purpoſely expoſed ſome of this maſs for a pretty while to a moiſt air, we found, as we looked for, that the formerly inviſible particles of ſalt, that had ſo inſinuated themſelves into the amalgam, that all the water, wherein it was waſhed, did not ſeparate them from it, had ſo wrought upon the metalline particles, that were moſt outward, that they had in many parts of the ſurface of the maſs turned themſelves with it into a kind of verdigreaſe, which ſeemed almoſt to hide the ſurface of the concretion. And that in the more inward parts of a much harder body than our yielding amalgam, where cupreous particles abound, ſaline corpuſcles may have a great operation, may appear by certain ſorts of minerals to be found in ſome parts of *England*, and elſewhere, under the form of ſtones, of which they make vitriol: for theſe abounding with vitriolate, that is, both ſaline and metalline particles, will, after they are taken out of the ground, and laid in the open air, by the working of the inward ſalt, ſome ſooner and ſome later, ſwell and burſt aſunder, which could hardly come to paſs, without a great change made in the internal diſpoſition of the parts of ſuch ſtony concretions. And I remember, that having laid a mineral, of kin to theſe ſtones, a while in the air, though but in a chamber, I found its ſurface powdered with little grains of vitriol, as both their colour and their taſte informed me.

Now whether or no we ſuppoſe, that the fire did put the parts of the amalgama into any laſting agitation, yet the maſs being almoſt fluid after it was taken from the fire, its parts may, according to our notion of fluidity, be well ſuppoſed to have ſome kind of motion among themſelves; and it will not be denied, that the fire might concur with other things, to make that motion convenient to cauſe the parts to faſten themſelves to one another: for that the motion, wherein a ſoft and almoſt fluid body is once put, may poſſibly tend to harden it long after that motion ſeems to be extinct, may be made probable by what has been affirmed to me by eminent and experienced maſons, namely, that the beſt ſort of lime made into mortar will not have attained its utmoſt compactneſs till twenty-five or thirty years (perhaps not till three or fourſcore) after it has been imployed in building; and this is given me as one of the reaſons, why in the demoliſhing of antient fabricks, it is ſometimes more eaſy to break the ſtone than the mortar.

AND laſtly, that we alſo made mention of the texture reſulting from the mingled ingredients of our amalgam, we might juſtify by ſaying, that having changed the proportion of the quickſilver to the verdigreaſe, we found, that the amalgam coagulated much more ſlowly, and, when it was coagulated, was much leſs hard, than when one uſed the quantities above ſpecified.

HERE I ſhould put a period for the preſent to this diſcourſe, but that having in a late writer met with a notable obſervation of the natural induration of a ſoft body, I think it worthy to be here annexed; partly, becauſe the French book is not common, no more than the obſervation; and partly, that by conferring together this natural induration with that artificial one freſhly mentioned, it may the better appear, how nature and art have ſometimes reſembling operations in rendering bodies ſolid. My * author then (by name *Pierre Pelleprat*) being not long ſince ſent with ſome other Jeſuits

* *Relation des Miſſions des P. P. J. J.* Part. II. Cap. 1.

ſuits upon the laudable errand of preaching the goſpel to the Indians of the Southern *America*, has among other things this paſſage in the ſhort relation he makes of the American continent: 'There is (ſays he) one thing wor-'thy of obſervation near the mouth of this 'great river, (he ſpeaks of that of the Ama-'zons) which is, that men find there a kind of 'green clay, that is ſoft as long as it is in the 'water, ſo that one may print on it all kind 'of figures, and give it what ſhape one pleaſes; 'but when it is expoſed to the air, it hardens 'to that degree, that diamonds are not much 'harder than the ſtones it affords.——I have '(adds he) ſeen hatchets made of this clay, 'which the ſavages employed to cut wood 'with, when they had not the uſe of ours, '*&c.*'

AND now at laſt, I ſee it is time to put a period to a diſcourſe, that has been unawares lengthened far too much already: but yet I think you will eaſily pardon me, if I conclude it not abruptly; but with the recital of an experiment, which having had the honour to be ſeen, as to the main part of it, by an illuſtrious meeting of curious men, their having been pleaſed to ſpeak very advantageouſly of it to others excited a curioſity among them, to know by what artifice effects, that were ſo uncommon, had been produced. The ſcope therefore, and the manner of making the experiment, were in ſhort as follows.

BEING deſirous to ſhew, how much fluidity and firmneſs may depend upon the texture and upon the motion or reſt of the inſenſible parts of bodies, I firſt make with good ſpirit of vinegar, a ſolution of coral ſo ſtrong, that when it is filtrated and cooled, it will commonly, after ſome time, begin to have a kind of ſediment at the bottom; the clear liquor I gently pour off, when the experiment is to be made, and to this I put a convenient proportion of very well dephlegmed ſpirit of wine, which, if it be poured on very ſlowly and warily, may be made for a pretty while to ſwim upon it in the form of a diſtinct liquor: but if by a few ſhakes I mingle them together, they will preſently unite into a concretion, of which, when the experiment ſucceeds very well (as it did when I ſhewed it to the above-mentioned aſſembly) not one drop will fall to the ground, upon turning up the wide-mouth'd glaſs it ſhould be made in, and holding it with the mouth directly downwards.

AND this ſo haſtily-produced conſiſtence may be durable enough, if it be carefully looked to: but to diſpatch the whole experiment in a ſhort time, I take a little ſtrong ſpirit of nitre (which perhaps is not needful if good aqua fortis be at hand) and putting about an equal, or other convenient quantity of it to this mixture, I nimbly ſtir it and the ſpirit together: whereupon the whole is reduced in a very few minutes to a tranſparent liquor.

N. B. THOUGH I have divers times made and ſhewn this experiment, yet there are ſo many circumſtances requiſite to make the firſt part of it ſucceed very well, (for to make it ſucceed in ſome meaſure is not ſo difficult) that the event has ſometimes deceived me, in ſpite of the ſeveral trials I have made. Wherefore it will not be amiſs to intimate,

FIRST, That one of the firſt times, if not the firſt, I made ſuch an odd concretion, was, with the ſolution not made with ſpirit of vinegar, but with ſpirit of verdigreaſe: (which I commonly diſtil without additament) though afterwards I was invited to prefer ſtrong ſpirit of vinegar, which was the liquor, wherewith the recited experiment was exhibited.

SECONDLY, That it often happens, that if the ſolution of coral (which is not the only body wherewith I have made ſuch trials with indifferent good ſucceſs) be not ſufficiently ſtrong and impregnated with ſaline parts, or the ſpirit of wine be not ſufficiently rectified, the ſhaking of the two liquors will not change the conſiſtence of the whole mixture, but leaves ſome part of it fluid; or elſe the concretion will not begin preſently to be made, but require to be waited for a while.

THIRDLY, That I once at leaſt (if not oftener) obſerved, that when by mingling the two liquors and ſhaking them in a narrow-mouthed glaſs, whoſe orifice was ſtopped, they would not concoagulate (as it was confidently expected they ſhould) yet by trying the experiment in a wide-mouthed glaſs, to which the air had free acceſs, it ſucceeded to my content.

FOURTHLY, That in the reduction of the concretion to a fluid body, it is not proper to employ in ſtirring it a knife or any other metalline body except it be of gold; but rather ſome ſtick of glaſs, or at leaſt ſome clean ſtick of wood, leſt the menſtruum ſhould corrode it, and thereby ſpoil, or at leaſt blemiſh the experiment.

FIFTHLY, that the proportion betwixt the coralline ſolution and the ſpirit of wine depends ſo much upon the ſtrength of the former liquor, and the dephlegmedneſs of the latter, that it is ſcarce poſſible to determine generally and exactly, what quantity of each ought to be taken; and therefore a trial or two made with a little of the particular ſolution you intend to employ (for ſome ſolutions require more, others leſs ſpirit of wine to concoagulate adequately with them) will better direct you, what proportion of ſpirit will ſuit that particular parcel of liquor, than any general rule I can propoſe.

I KNOW I might here, and perhaps it may be expected, that I ſhould take an occaſion to treat alſo of hardneſs, ſoftneſs, brittleneſs, toughneſs, ſtiffneſs, and thoſe other qualities, that are of kin to fluidity and firmneſs; but though I confeſs, I once had thoughts of writing a kind of hiſtory of more qualities than thoſe, yet remembering that wiſe counſel given us by one of the ancients, *Noſcenda eſt menſura ſui*, I am now very well content, after having already tired my ſelf and, I fear, you, to recommend ſo uſeful but difficult a work to perſons more able and more at leiſure, than I find my ſelf, to go through with ſo great an undertaking; contenting my ſelf at preſent, to have attempted in what has been delivered concerning a couple of qualities of ſuch extent, that every ſenſibly big body in the univerſe ſeems indowed with

one or other of them (I mean concerning fluidity and firmneſs) the explicating of qualities ſomewhat more intelligibly than is wont to be done in the Peripatetick ſchools, and to have opened a way (which I hope many will tread) of applying chymical obſervations and experiments to the deduction of thoſe effects of qualities from ſuch general and obvious affections of matter; as bigneſs, motion, and figure, which even the hermetical writers have hitherto contented themſelves to refer to ſalt, ſulphur, mercury, and the like: the chymical notion of which three principles, though of very good uſe in ſome other (eſpecially of the more practical) parts of phyſiology, ſeems not as yet to have brought any great light to ſuch matters as we have been treating of, having been hitherto directed not ſo much to the indagation of cauſes, as to the production of effects.

OF ABSOLUTE REST IN BODIES.

An Advertiſement.

SINCE it hath not been thought amiſs, that ſomething ſhould be intimated to the reader about the occaſion of the enſuing tract, I ſhall acquaint him, with it as briefly as I can, by telling him, that it was this. Some very ingenious gentlemen happening to meet as viſitants at the author's lodgings, fell accidentally into a diſcourſe about the abſolute reſt ſuppoſed to be in many bodies, that ſeemed to have its riſe from a miſtake of the true meaning of a paſſage or two in the *Hiſtory of Fluidity and Firmneſs*, (that was then reprinting.) But the conference chancing to have a period put to it, whilſt ſeveral things pertinent to the author's purpoſe remained yet unſaid; the curiouſneſs of the ſubject invited him to draw up (haſtily enough) the ſum of what he had ſaid, and might further have ſaid, if opportunity had ſerved, about the point in debate, for the further ſatisfaction of an inquiſitive virtuoſo, that was preſent at it. And this was the riſe of the following diſcourſe, which being written on an occaſion adminiſtered by the *Hiſtory of Fluidity and Firmneſs*, whereof a new edition was ready to come abroad; it was thought not improper, that this tract ſhould attend it, as a kind of Appendix, without the firſt and laſt part of a letter, whereof the body only is neceſſary to the deſign of it.

An ESSAY of the inteſtine Motions of the particles of quieſcent Solids:

Where the abſolute Reſt of Bodies is called in queſtion.

SECT. I.

TO remove the doubt or ſcruple, that began to be diſcourſed of juſt before we laſt parted, I ſhall need to do little more than enlarge the particulars, which (you know) I had then time but briefly to make mention of. For the ſtate of the queſtion was (as you may remember) this, *Whether there be among bodies any abſolute reſt?* On which occaſion I anſwered, that reſt being a word, that to me ſeemed ſomewhat ambiguous, I thought it was requiſite to clear the ſenſe of the queſtion, before I offered at anſwering it.

FOR the word reſt, when we ſpeak of diſtinct maſſes of matter, looked upon as quieſcent, does in the vulgar acception of the term ſignify, ſuch a ſtate of a viſible and entire body, or (rather) of the corpuſcles it conſiſts of, that they are actually unmoved as to ſight; the eye (and perhaps not the touch) being not able to diſcern any local motion in them.

CONSONANTLY to this firſt member of the diſtinction of the word *reſt*, I briefly intimated to the company, that in this ſenſe of a corpuſcle's being at reſt, I thought it manifeſt, that there is ſuch a thing *in rerum natura*; ſince without granting ſuch a reſt in the component particles of ſome kind of bodies, as diamonds, iron, porphyry, *&c.* it will be (I conceive) very hard to explain, how there can be ſuch ſolid maſſes (as thoſe minerals are) made up of ſmall and ſeparable particles. Which being ſaid, I added, that I ſaw no reaſon, why ſuch a kind of firmneſs, where the inward motion of the inſenſible particles is almoſt infinitely ſlow, may not ſuffice to give an account of as great a firmneſs as

we uſe really to find among conſiſtent bodies.

BUT whereas I had intimated to the company, by the lately begun diſtinction, that beſides this popular ſenſe of the word reſt, there was a ſecond more rigid and philoſophical notion, or kind of reſt, which for diſtinction-ſake may be called abſolute or perfect reſt, which imports a continuance of a body in the ſame place *preciſely*, and includes an abſolute negation of all local motion, though never ſo ſlow or imperceptible; I told them, that in this rigid ſenſe of the word reſt, I durſt not affirm, that there are any bodies at reſt in the univerſe (at leaſt for any long time) but willingly allowed it to be made a problem, whether there be any or no; adding, that perhaps I inclined to the negative part of the queſtion.

HAVING thus hiſtorically ſummed up what paſſed betwixt us about the ſtate of the controverſy, I need not tell you, that the doubt I expreſſed was thought to reliſh too much of a paradox; and therefore ſince the company's quick ſeparation allowed me then no opportunity of enlarging, and ſince I promiſed no better arguments, than might be expected in a point, that I propoſed but as problematical; I ſhall now endeavour to ſhew you, that the ſide of the problem I was judged inclined to, is (at leaſt) not ſo improbable as ſome thought it.

TO prove negatives directly, being wont (as you well know) to be no eaſy taſk, and eſpecially in ſuch caſes as this; you will not, I preſume, expect, that I ſhould attempt the proving of my conjecture otherwiſe than by ſhewing poſitively, that ſome of thoſe bodies, which we think to have their parts moſt at reſt, are not exempted from having inteſtine motions in them; ſince it will be conſequent to ſuch a proof, that it muſt be probable, that in other bodies, whoſe ſolidity is confeſſed to be inferiour, the component particles are not in a ſtate of perfect reſt.

SECT. II.

IF it were neceſſary and expedient, I ſhould begin my arguments by ſaying ſomething againſt abſolute reſt, in favour of the contrary opinion, by arguing *à priori*, as they ſpeak, from the conſtitution of the world, whether we conſider it according to the Epicurean or the Carteſian hypotheſis of the origin of things. For the Epicureans ſuppoſing this world to be produced by the caſual concourſe of atoms, and aſcribing to every particular atom an innate and unloſeable mobility, or, rather, an actual motion, or a reſtleſs endeavour after it; it is conſonant to think, that though in concretions they ſo entangle one another, that they cannot in a ſhort time, or a viſible manner clear themſelves from one another, yet they do inceſſantly ſtrive to diſ-entangle themſelves and get away: by which means there are always in the atoms even of ſolid bodies actual endeavours of each of the diſtinct atoms to extricate it ſelf from the reſt; (which endeavours uſually at laſt ſucceed, whence comes the decay and deſtruction of bodies:) and in the mean while theſe perpetual and contrary endeavours produce inteſtine commotions in the internal parts of the body, wherein theſe atoms were impriſoned.

ON the other ſide, according to the Carteſian doctrine, the *materia ſubtilis*, that conſtantly paſſes like a ſtream through the pores even of the ſolideſt bodies, may well be ſuppoſed in its paſſage to be continually ſhaking, or otherwiſe agitating the inſenſible particles, that make up the body, that ſeems to be at reſt, without diſcovering their motion to the eye: as when in ſummer-time (to explain my ſelf by a compariſon) a gentle breath of wind paſſes through a grove removed a pretty way off from the ſpectator, though his eye diſcern no change in the grove he looks on, yet the wind, as it blows through the trees, will ſhake ſome of the branches as well as the flexible twigs; and not only blow the leaves into various poſtures, but blow ſome of them quite away.

I MIGHT eaſily enlarge on this ſubject, but having elſewhere done it on another occaſion, I think it may be now more proper to ſatisfy ſome of the company, who are yet entangled with the ſame prejudice with many other very learned men, who look upon it as a precarious and chimerical fancy of the Atomiſts, to imagine, that in ſolid, and, as to ſenſe, quieſcent bodies, there ſhould be any inteſtine motion of the component particles, neither the motions nor the corpuſcles themſelves being to be ſeen, and both of them being therefore as well incredible as inviſible.

A SOLEMN debate of the whole queſtion about the minuteneſs of atoms belongs not to this place, where it may ſuffice to anſwer the objection.

SECT. III.

AND firſt, as I have elſewhere hinted, it may appear by divers of the phænomena above-cited, (in the *Hiſtory of Fluidity*) that when water and ſeveral other liquors ſeem to be continued maſſes of matter, and to be as much at reſt, as the very glaſſes, that contain them; their conſtituent corpuſcles are in an actual and various, though ſlow and unperceived, motion.

NEXT, that there may be likewiſe ſuch a motion in the minute parts of ſilver and iron themſelves, may be eaſily argued, by heating thoſe metals, till they come to be almoſt red hot: for then, though the eye can diſcern no motion of the corpuſcles thoſe metals conſiſt of, yet their being able to burn thoſe, that hold them in their naked hands, ſhews, that their briſk motions may be diſcovered by the help of the touch; and if you ſpit upon them, the liquor will boil, as if it were over the fire. And leſt it ſhould be objected, that ſo anomalous and violent an agent as the fire is neceſſary to theſe trials, I ſhall add, that, provided the minute parts be ſufficiently agitated, it matters not, whether the motion be produced by fire or no: for by the nimbly hammering of iron or ſilver, you may put the minute parts into ſuch a motion, as will make the metal very hot to the touch, and being communicated to ſpittle or water, will excite bubbles, and ſcatter the diſſipated parts of that liquor into the air, in the form of ſmoke or vapours;

pours: nay, I elſewhere ſhew, how I have eaſily excited a very ſenſible, though not a viſible agitation, and heat in the internal parts of a metal, barely by my naked hands, without any external inſtrument whatſoever.

And whereas it may be objected, that though the motion already generated is unſeen, yet we may diſcern a change of the component corpuſcles of a body, which are in the act of altering its texture, and introducing a new alteration or quality in the body to be wrought on, or deſtroying ſome pre-exiſtent quality: I briefly anſwer (for I would not here repeat what I have elſewhere ſaid of this point) by this clear experiment, that though your eye can diſcern no change in the outward and viſible, much leſs in the more latent and internal corpuſcles of iron; a vigorous loadſtone, by paſſing along its axis from one pole of the ſtone to the other, and back again, yet the texture of the iron is by that action of the loadſtone ſo changed, that it acquires, and then loſes thoſe admirable qualities we call the attractive and directive virtue or faculty peculiar to magnetical bodies.

And to ſhew you, that the inviſible motions even of metalline bodies may be quick and briſk enough, and may be ſenſible, though not viſible; we ſhall need to conſider but the ſtate of a good bell ſo long after the clapper has ſtruck it, that no ſhaking or other motion is to be ſeen in the body of the bell it ſelf, and yet it cauſes in the air an odd kind of ringing, or, if I may ſo call it, undulating ſound or motion, which will ſometimes laſt a conſiderable while; and if the bell be fitted for ſharp notes, it will not be without a ſhrilneſs: for if ſounds proceed, as is elſewhere made probable, from the nimble percuſſions of the air put into a quick and waving motion by ſonorous bodies. this acuteneſs of ſound will ſhew, that whilſt to the eye the bell ſeems to be at reſt, yet the minute parts of it continue in a very briſk motion, without which they could not ſtrike the air ſtrongly, and faſt enough, to make it produce ſo ſhrill a noiſe in the ear.

But, I confeſs to you, that my thoughts preſent me a difficulty, which, though un-mentioned at our meeting, may afford an objection, perhaps more difficult than any of (not to ſay all) the foregoing; namely, that it is ſcarce imaginable, how ſuch ſolid and hard bodies ſhould have their internal parts wrought upon by ſuch ſlight agents as the air, and perhaps ſome yet minuter matter, that is diſperſed in it; and how it is poſſible, that where there is an actual motion, it ſhould be ſo ſlow, that a corpuſcle of iron, for inſtance, ſeated in the internal part of a magnetick needle, ſhould ſpend ſo long time, as our conjecture requires, in travelling ſo little a ſpace as from thence to the next ſuperficies of the needle. But to this double objection, though ſome inſtances, which you will meet with in the following part of this paper, may be properly applied to ſolve it; yet not to make your curioſity wait, I will here ſpeak a word or two to each of the members of the objection.

SECT. IV.

And to the firſt, I ſay, that theſe inteſtine motions of the corpuſcles of hard bodies need not be ſolely, nor perhaps principally aſcribed to thoſe obvious external agents, to which we are wont to refer them, ſince theſe may but excite or aſſiſt the more principal or internal cauſes of the motions we ſpeak of, as you may gather from what was but lately mentioned of the connate and unlooſeable mobility of the atoms, according to *Epicurus*, and the permeation of the moſt ſolid bodies by the Carteſian *materia ſubtilis*; and we may ſee by the ſudden effects of the loadſtone, in endowing ſteel with magnetick qualities, and depriving it of them again, (both which ſuppoſe the intervention of a change of texture, and this a production of local motion in the metal) that very minute and inſenſible corpuſcles of matter are not uncapable of effecting durable changes in the ſolideſt bodies.

And as for the other member of the objection, I confeſs it is not eaſy for us, who are wont (perhaps too much) to follow our eyes for guides in judging of things corporeal, and to deny exiſtence to moſt things, whereto nature has denied a viſible bulk: it is not eaſy, I ſay, for us to imagine ſo great a ſlowneſs, as it is very poſſible for nature to make uſe of her operations, though our not being able to diſcern the motion of a ſhadow of a dial-plate, or that of the index upon a clock or watch, ought to make us ſenſible of the incompetency of our eyes to diſcern ſome motions of natural bodies, which reaſon tells us ought to be incomparably ſlower than theſe. But not now to diſpute about the exiſtence and attributes of infinite ſlowneſs, or at leaſt a ſlowneſs in the next poſſible degree to infinite; I conſider, that it has not, that I know of, been demonſtrated, nor attempted to be ſo; that the motion of the corpuſcles, for example, of the needle above-mentioned, muſt be made in a direct line from the place, where it was firſt ſuppoſed to be, to the ſuperficies of the needle; for it ſeems more rational, and to agree better with the phænomena, to ſuppoſe, that the way of this corpuſcle in the body it would quit is extremely crooked and intricate (almoſt like that of a ſquib in the air, or on the ground) for it being on the one hand urged on by the cauſes, whatever they be, that make it ſtrive to fly away, and on the other hand hindered by the corpuſcles, whereto it is connected, and by the occurſions of other corpuſcles, whoſe motions may be oppoſite to, or diſagreeing with thoſe of our deſigned corpuſcle; it may probably, before it can extricate it ſelf, be reduced to encounter and wreſtle, as it were, with many other corpuſcles, and be by them ſometimes thruſt or impelled to the right-hand and to the left, and ſometimes alſo repelled inwards, even after it is come to the ſuperficial part of the needle, whence it may not preſently have the the liberty to fly away, but may be drawn back by ſome other corpuſcle, wherewith it is yet connected, and which happening to be it ſelf thruſt inward, may draw after it, and ſo entangle

tangle again our almoſt diſbanded corpuſcle: beſides that the gravity of the component particles of a body is oftentimes ſuch, that it is eaſier for the agent, that puts them in motion, to continue them in that ſlow motion among themſelves, than drive them up into ſo light a medium as the air; as experience ſhews in thoſe bodies, that are called fixed, as gold, and glaſs, though in actual fuſion.

BUT I forget, that I promiſed you to decline ſpeculations, and therefore I ſhall only name to you a couple of inſtances, which will ſerve to confirm both what I was lately ſaying, and what I am now in proving.

SECT. V.

THE firſt of theſe I ſhall take from what is uſually granted as matter of fact; namely, that if a ſpring, though made of ſo hard a body as ſteel, be forcibly bent, and kept but a moderate while in that poſture, as ſoon as the force, that kept it bent, is removed, it will again return to its former figure; but if it be kept too long in that forced poſition, it will by degrees loſe that, which they call the motion of reſtitution, and retain its new crooked figure, though the force, that bent it, be removed; which ſhews both the power of ſome of the more familiar agents in nature, and (which is that, the ſhewing whereof I here chiefly aim at,) that where there is a continued endeavour of the parts of a body, to put themſelves into another ſtate, yet the motion, or rather the progreſs may be much more ſlow, than men ſeem as yet to have taken notice of, ſince it was a great while before the texture of the corpuſcles of the ſteel were ſo altered, as to make them loſe their former ſpringineſs.

BUT I will ſecond this with a more illuſtrious experiment, which will at once confirm what I have juſt now ſaid, and ſhew, that the air or the inviſible corpuſcles harboured in it may have no inconſiderable power to act upon, and effect changes in the ſolideſt bodies,

TO this purpoſe I ſhall only obſerve to you, that though if a bar of iron having one of its ends held perpendicularly, and at a fit diſtance, to the lily or north-point of the mariner's-compaſs, (I mean that, which points towards the north) it will, as I elſewhere mention, drive it away towards the eaſt or weſt: and if this ſame lower end of the bar of iron be put into a contrary poſture, it will preſently loſe its temporary magnetiſm, as I elſewhere declare. Yet, if this bar be very long kept upright in a window or other convenient place, then, as ſome late magnetical writers will tell you, it will have acquired a conſtant and durable magnetick power. Which is a phænomenon, that makes exceedingly for our preſent purpoſe, ſince it hence appears, both that the air, together with the magnetical effluvia of the earth, that it receives in its pores, is able without outward force to work durable changes in ſo ſolid a body as iron, and that the motions of the internal parts, (for theſe are requiſite to the change of the metal's texture,) are performed with a wonderful ſlowneſs, ſince the bar muſt be very long expoſed to the air, perhaps before it acquires any durable magnetiſm at all, but at leaſt before it acquires ſo vigorous and fixed a magnetiſm, as by this means it may attain to.

BUT, becauſe moſt of the inſtances to be propoſed in the following part of this eſſay may ſerve for confirmations of what we have been diſcourſing, I ſhall proceed to them; yet not till I have advertiſed you, that I purpoſely decline to mention divers phænomena, that may even by learned men be thought fit examples on this occaſion, (ſuch as the nutrition, growth, and waſting of animals and vegetables) becauſe ſuch bodies receiving conſtant ſupplies of corpuſcles, of ſeveral, and often unknown, natures, there may be difficulties ſuggeſted about them, not eaſy to be cleared without longer diſcourſes, than I can allow this eſſay.

SECT. VI.

THE firſt inſtance then, that I ſhall mention about vegetable ſubſtances, ſhall be taken from *lignum vitæ*, or *guaiacum*, (for many artificers give them the ſame name, and uſe them promiſcuouſly for the ſame purpoſes;) of which, though it ſeem to be the ſolideſt wood we know, (inſomuch, that I as well as ſome others have ordinarily uſed it to pound ſolid bodies in) yet the ſkilfulleſt tradeſmen I have met with, have upon my inquiry informed me, that if it be wrought, before it be well ſeaſoned by length of time, it will ſhew itſelf very frangible; which an eminent turner told me he had often found to his loſs: for having turned divers fine pieces of work of *lignum vitæ*, before it was duly ſeaſoned, he found almoſt all of them by the heat of the ſun (which the uſes of many of them required they ſhould ſometimes be expoſed to) crack, and cleave aſunder, into I know not how many parts; whereby thoſe fine pieces of workmanſhip were quite ſpoiled. And I remember, that having inquired of an old experienced tradeſman, of whom I bought an excellent mortar of *lignum vitæ*, how long he had kept the wood in ſeaſoning before I had the mortar, he anſwered me (if I much miſ-remember not) twenty years, under which time it is not fully ſeaſoned for ſome purpoſes; of which opinion of his having occaſionally ſpoken to the lately-mentioned turner, this experienced workman much confirmed me in it; as he likewiſe did in an obſervation I not long ſince made about the ſlow and unperceived motion, that may be, not only in the more looſe and fugitive aqueous parts of *lignum vitæ*, but in far more unlikely ones. For he told me, that he had often found, in turning that wood, cavities of ſeveral ſizes in the very inward and ſolid part of the wood (which every way encompaſſed them) and in thoſe cavities conſiderable quantities of a certain gum, much cried up by ſome for an anti-venereal medicine.

THE uſe I would make of theſe examples is this, that ſince ſo ſolid a body as a trunk of *lignum vitæ* is, when the tree is newly felled, may require ſo long a time as twenty years, or upwards, to be ſeaſoned, *i. e.* brought to its full

full compactneſs and toughneſs: and ſince the account, upon which time ſeaſons wood, ſeems to be this, that by degrees the looſer aqueous, and more fugitive parts exhale into the air, whereby the remaining ſolid ones are brought into a cloſer order, and have leiſure to be ſo placed among themſelves, as is moſt convenient to make their texture firm and durable; it will follow, that even in the internal parts of this ſolid wood there muſt be, not only in the looſer and lighter corpuſcles, that extricate themſelves, and exhale away, a true local motion, though much too ſlow to fall immediately under the diſcernment of our ſenſes. And, if the lately mentioned gum be either totally, or ſo much as in part generated, as to ſenſe, after the felling of the tree, as ſome analogous inſtances, that I have elſewhere taken notice of, make it probable; then the example will further be conſiderable to our preſent purpoſe, by ſhewing, that a ſubſtance ſo groſs, and ſo little volatile in compariſon of the aqueous parts, as is the brittle gum I ſpeak of, may permeate, to a great thickneſs, a very ſolid and inanimate ſubſtance; which cannot be done without an inteſtine, though inſenſible motion among the parts of the wood, and probably a marvellouſly ſlow motion of thoſe of the gum.

SECT. VII.

BUT it will poſſibly ſeem more ſtrange, that very thin pieces of wood, and thoſe ſawed off from a tree of a much looſer texture, ſhould be much longer in ſeaſoning, than that ſolid and ponderous wood we have been ſpeaking of. And indeed this diſcovery is not to be made, as in *lignum vitæ*, by the brittleneſs, or other obvious qualities in the wood, but by a ſubtiler way: and accordingly having purpoſely conſulted with the makers of muſical inſtruments, and with ſome ancient muſicians, I was much confirmed by them in my opinion: and I remember, the laſt maker of viols, lutes, &c. of whom I inquired of what age he thought ſuch inſtruments, eſpecially lutes, ought to be, to attain their full and beſt ſeaſoning for ſonorouſneſs; he replied, that in ſome of them twenty years would be requiſite, in others forty, according to the nature and thickneſs of the wood, and other circumſtances. But an ancient muſician, that was preſent at what was ſaid, informed me, that there were ſome famous lutes, one or two of which he named to me, that attained not their full ſeaſoning and beſt reſonance, till they were about fourſcore year old. And thus much for inanimate vegetable ſubſtances.

SECT. VIII.

As for calcined ſtones made up into lime, and ſorts of raw ſtones, I have already obſerved from the credible relations of maſons and others, that the walls in ſome buildings attain not their hardneſs and ſolidity, till they are forty years old, or perhaps much ancienter; and ſince in gradually proceeding to this degree of ſolidity, theſe walls reſemble the ſeaſoning of *lignum vitæ* formerly explicated, the motion of the internal parts may be argued from the change of texture as well in theſe as in that.

AND, if I would rob other tracts (to which they more properly belong) I could here eaſily add ſome ſuch inſtances of the hardening and ſoftening of ſtones by time, as would much confirm what I have now been delivering; but I ſhall rather chuſe to confine myſelf here to the two examples following, not taken notice of in quarries or by maſons.

THE firſt is, that there are marchaſites, conſiſting as well of a ſtony as of a metalline ſubſtance, which, though harder than many other ſorts of ſtones, and even than marble, have yet ſo great a motion in their internal parts, that if they be expoſed to the air, not only they will have a vitriolate efflorescence, if I may ſo ſpeak, on their ſuperficies (as I have obſerved in divers other marchaſites) but they will in tract of time burſt the ſtone in pieces; of which ſort I had ſome time ſince, and I hope I have yet a bulky marchaſite, that I procured from a virtuoſo, that lives juſt by a vitriol-work, whither theſe among other vitriol-ſtones are brought, and where this ſtone being choſen for its largeneſs, was taken up, and carefully kept by that ingenious perſon, till it burſt of itſelf, and till I ſent for it. And to ſatisfy myſelf a little further, that the internal parts of marchaſites may be as well diſpoſed to be vitriolated as the external; I remember I broke a hard marchaſite, that I had from another place, and laying it ſome ſhort time in a chamber-window, I found the new ſuperficies made by the fracture about the middle of the ſtone to have acquired an efflorescence of a vitriolate nature.

THE other inſtance, which is very odd, and much talked of, is this: an ingenious gentleman of my acquaintance, caſually meeting me one day, told me, that he had a turquois-ſtone, which, if he were not miſtaken, had a wonderful property; for there being in it ſeveral ſpots of colours differing from the reſt of the gem, theſe ſpots ſeemed, though very ſlowly, to move from one part of the ſtone to the other. And this he thought himſelf to have taken notice of for very many months, (perhaps a couple of years.) This relation ſeemed ſo ſtrange, that the relator was not at all ſurprized, when to aſcertain my ſelf of the truth of it, I deſired to have the ring, this ſtone was ſet in, for a while in my own keeping; to which he readily aſſenting, beſides that I took very heedful notice of the ſituation of the ſpots, I employed a very ingenious youth, that then lived with me, and was ſkilled in drawing, to make the picture of the ſtone with the ſpots as they were then placed, and afterwards to have a watchful eye upon it, and from time to time (as once perhaps in two or three weeks) to draw a new picture of them; by comparing of ſeveral of which pictures, it was unanimouſly concluded, that the ſpots did ſhift places in the turquois, as if the matter they conſiſted of made its way through the ſubſtance of the ſtone; as we lately noted, that the gum of *lignum vitæ* ſeemed to do through the ſubſtance of the wood. And as far as we obſerved, the motion of theſe ſpots was exceeding

ceeding ſlow and irregular, though perhaps it might have been reduced to a ſomewhat leſs uncertainty, were it not, that by an unwelcome accident we were deprived of the opportunity of continuing our obſervations long enough. And this brings into my mind, that the turquois being a ſtone, of which I had met ſtrange ſtories in good authors, I once aſked ſeveral queſtions about it of a noted jeweller; and inquiring, among other particulars, whether he had not obſerved ſome changes, that ſeemed ſpontaneous in the ſubſtance or colour of the ſtone? he replied, that in ſome few turquoiſes he had obſerved two differing blues in differing parts of the ſame ſtone, and that one of thoſe colours would by ſlow and unperceived degrees invade, and at length overſpread that part of the ſtone, which the other colour poſſeſſed before. I ſhall here add, that the ſame gentleman, that lent me the ſpotted turquois, ſhewed me afterward an agate haft of a knife, where was a certain cloud, which he told me an ingenious perſon had for ſome years obſerved to remove to and fro in the ſtone, and had a while ſince, to convince the relator, lent him the agate, of whoſe phænomena he promiſed me an account, when he ſhall have had the ſtone in his cuſtody for a competent time; till the expiration of which, it may ſuffice to have ſaid of this agate what I have now related.

SECT. IX.

BUT becauſe that diamonds and glaſs are generally looked upon, eſpecially by chymiſts, as bodies of the cloſeſt and firmeſt texture, that nature and art afford, if we could ſhew an inteſtine motion even in the parts of theſe, fitter inſtances for our purpoſe could not in reaſon be deſired; I ſhall venture to ſay ſomething of each of them, though what I have to ſay about diamonds, is propoſed rather to ground a ſuſpicion of what may be, than a demonſtration, that it muſt be.

IN the firſt place then, to remove that prejudice, that may be entertained from the incomparable hardneſs of diamonds (which I confeſs experience has made me admire) as if bodies ſo hard and ſolid could not have their parts put into motion but by ſome extraordinary, not to ſay, prodigious force; I ſhall only repeat here, what I have elſewhere ſhewn, that diamonds are bodies, that eaſily enough become actually electrical, and that ſome diamonds (of which ſort I have a ſmall one by me) will by rubbing upon a cloath be brought to ſhine in the dark; the quiſt of both theſe tranſient qualities requiring a change of texture even in the internal parts; and the friction that produces that change, doing it immediately by putting the parts of the ſtone into local motion, it may be thence argued, that a very moderate force may ſuffice to beget an internal motion in the inward particles of diamonds themſelves.

AND I am not ſure, but that more hidden agents may make impreſſions upon theſe hardeſt bodies. For in a ring, that I am wont to wear on my little finger, which has no diamond, ſave one more than that ſhining one I lately mentioned, I have, I know not how often, ſeemed to my ſelf to obſerve a manifeſtly greater clearneſs and ſparklingneſs at ſome times than at others, though I could not refer it to the clearneſs or dulneſs of the weather, the moiſture or dryneſs of the air, the ſuperficial clearneſs or foulneſs of the ſtone, or any other manifeſt cauſe I could think of. And in this I was the more inclined to think I might not be miſtaken, becauſe, beſides that the notice I took of it, was frequent, I have by me a rough diamond juſt as it came from the rock, in whoſe electrical faculty I have taken notice of changes as to the degree of ſtrength, wherewith it attracted, and that within the compaſs of a very little time, though I could not find any cauſe, whereto I could refer ſo ſurprizing a phænomenon. And I muſt not here omit, that chancing one day to ſhew the newly mentioned diamond ring to a very ingenious lady, that uſed to wear in rings and bracelets ſtore of thoſe gems, and telling her what changes I had taken notice of in the diamonds; ſhe, who had obſerved more about gems than any lady I had yet met with, appeared but little ſurprized at what I told her, and affirmed to me, that ſhe had divers times obſerved the like alterations in ſome diamonds of hers, which ſometimes would look more ſparklingly than they were wont, and ſometimes far more dull than ordinary. And when I objected, that poſſibly that dulneſs might be imputed to the weather, or ſome caſual foulneſs of the ſurface of the ſtone, ſhe replied, *that ſhe had* been aware of thoſe circumſtances, rubbing the ſtones clean, and otherwiſe taking care to ſecure an obſervation, which ſhe had made too often to have deceived her ſelf in it. If I remember aright, I have elſewhere mentioned how I ſaw a conſiderable, but cloudy, *Hungarian* diamond, which the owner would have preſented me, made clearer by lying for ſome time in a cold liquor; wherein he affirmed, that upon his keeping it longer the ſtone would loſe more and more of its cloudineſs; and what I myſelf ſaw ſufficed me to argue, that changes may be produced even in the inward parts of ſuch diamonds by agents, *that* act without any appearing violence.

SECT. X.

AND if it be true, that diamonds, as I elſewhere obſerve about many other ſtones, may be generated from time to time in the bowels of the earth, it may not perhaps be abſurd to imagine, that even true diamonds, that ſeem perfect, and are fit for rings, may long continue to have an inſenſible motion through the whole ſtone, whereby the corpuſcles it conſiſts of are diſpoſed into a more convenient texture for the conſtituting of an extremely hard body. For though it be taken for granted, that adamantine bodies, becauſe they are generally exceeding hard, are equally ſo, yet that ſuppoſition is not favoured by experience. And I remember, that to ſatisfy my ſelf further about ſuch matters, I repaired to an ancient artificer eminent in his trade, which was the cutting and ſetting of diamonds; and that having demanded of him, whether he found, that all diamonds were of equal hardneſs; he anſwered me, that

that having dealt in theſe gems near 20 years in *Amſterdam*, and divers years in *England*, he perceived, that there are of later years brought over worſe and worſe ſorts of diamonds; and that he finds ſeveral of the recent diamonds ſo ſoft and brittle in compariſon of thoſe he was anciently wont to ſet (and which he with other jewellers called diamonds of the old rock) that he is often afraid, and unwilling to meddle with them, when they are brought to him, leſt he ſhould ſpoil them in the cutting, or poliſhing. But this I only repeat hiſtorically, till further obſervation ſhall diſcover, whether theſe are diamonds not yet fully ripe, and capable of growing harder by further maturation; or whether they be of a peculiar ſort of diamonds, whoſe nature it is to be always ſofter than thoſe of the old rock.

SECT. XI.

THIS brings into my mind a confirmation of the unequal hardneſs of diamonds, whatever be the cauſe of it, which I met with in a little book, lately publiſhed in his own language by a Frenchman, who giving his reader an account of the eaſtern diamond-mines from the relation, as he affirms, of a late eye-witneſs, ſpeaks thus of the third and laſt mine called *Gazerpoli: They are very clear, and of a good water, but they cannot be ground by mutual attrition* (if I underſtand the term he uſes) *but with ſtones of the ſame mine; for if one ſhould employ for that purpoſe the ſtones of another mine, thoſe of* Gazerpoli *would be broken in pieces. They do alſo eaſily break upon the wheel, and thoſe, that are not verſed in the knowledge of ſtones, may eaſily be deceived* (in them.) Of which our author adds the example of a Portugueſe, who refuſing 1200 crowns for one of them at *Leghorn*, when he went to have it cut at *Venice*, it broke upon the wheel into fifteen or twenty pieces.

Egrezes, pag. m. 17, 18.

ANOTHER example, that ſeems to make more for our preſent purpoſe, is afforded by the ſame author, ſpeaking of the ſecond mine, which breeds the greateſt ſtones called gane or colonor; for he ſays, that *ſur la plus part, i. e.* upon the moſt of theſe ſtones after they are cut, there appears always, as it were, a kind of greaſineſs or unctuoſity, which invites you ever and anon to have recourſe to your handkerchief to wipe it off, which one would gueſs to proceed from ſome inſenſible effluvium, that exhaling out of the ſtone, comes to be checked and condenſed by the air on the ſuperficies of it, as it happens to ſweat on the ſkins of animals: the truth of which conjecture I would examine by very nice ſcales, if I could procure ſuch diamonds.

SECT. XII.

AND becauſe rubies, though inferiour in hardneſs to diamonds, are yet harder than moſt other gems, and much more than marble and the like coarſer ſtones, I will not omit, on this occaſion, what was more than once affirmed to me by an obſerving lady, whom, if ſhe were not too nearly related to me, I could ſcarce mention without an elogy. For caſually caſting my eye upon a fair ruby ſhe wore upon her finger, and deſiring to conſider it more attentively, ſhe pulled off the rich ring it was ſet in, and reaching it me, told me it was worth my curioſity to conſider it. For beſides that it was ſo fine a ſtone, that it was thought worth being left her as a legacy by a great lady (her dear friend) that was famous, as I knew, for the variety of the rich jewels ſhe was miſtreſs of; this ruby would not unfrequently vary the degrees of its luſtre, ſhe knew not why. For ſometimes it ſeemed to be ennobled by a more vivid fire than ordinary, and at other times it would be manifeſtly more dull and cloudy than it is wont to be: and this not imputable, as ſhe expreſly aſſured me upon repeated obſervations, to the cloudineſs of the weather, or any ſuperficial foulneſs of the ſtone. And, that I might be convinced as well as ſhe her ſelf was, ſhe deſired me to rub it very clean, and then take notice of the preſent luſtre of it, of which ere long ſhe preſumed ſhe could ſhew me a manifeſt alteration, (for I was then come to viſit her, and paſs ſome weeks with her in her houſe) but my occaſions calling me away within a few days after, I had not time to wait for the event of her promiſe.

HOW far what has been ſaid concerning diamonds may be allowed to be argumentative towards the ſcope of this diſcourſe, I ſhall willingly leave to the diſcovery of time, and further obſervation; the mention I have made of the foregoing particulars having been invited partly by the nobleneſs of the ſubject, which made me willing to add theſe relations to what I have elſewhere written about them; and partly becauſe thus much at leaſt ſeems probably deducible from what I noted about the exciting of diamonds by rubbing, both to attract, and to ſhine, that notwithſtanding their incomparable hardneſs, an inteſtine motion of their minute parts may be without any conſiderable violence quickly produced.

SECT. XIII.

AND now it will be time to conſider the other body I promiſed to take notice of, namely, glaſs. For this being thought ſo compact and firm a body, that it is indeſtructible by art or nature, and being alſo of ſo cloſe a texture, that the ſubtleſt chymical ſpirits (that are yet known) cannot pervade it; and laſtly having given ſuch proofs of the fixedneſs of its parts, as to have long indured the violence even of a glaſs-houſe-fire, we can ſcarce imagine a body more unlikely to have any motion amongſt its component particles: and yet, that they may not be always at perfect reſt among themſelves, I have been induced to think by the following, and the like obſervations.

FIRST, having inquired of a famous and experienced maker of teleſcopes, as well as of thoſe, that uſe ſuch inſtruments, whether he did not obſerve, that the Venice-glaſſes he employed would ſometimes crack of themſelves, whilſt

they were yet in plates, and ſometimes do the like after they were ground into convexes, and poliſhed up; he anſwered affirmatively. And though it ſeemed improbable, that glaſſes brought ſo far off as from *Venice*, and many of them kept a good while here in *England* before there be occaſion to grind them, and perhaps longer after their having been ground before they crack, ſhould after all this time retain an internal motion among their component particles; yet I have been induced to conjecture, that ſome ſaline corpuſcles, more numerous than the nature of the glaſs required, may by degrees, though ſlow and unperceived, ſo tend towards the ſuperficies of the glaſs, as either to get out of the pores of it, or crack, or burſt the glaſs in endeavouring to force their paſſage outward. For having purpoſely inquired of the abovenamed artificer, and ſome other obſerving men, that deal in optical glaſſes, whether it had not been taken notice of, that there would ſometimes be, eſpecially in winter and very moiſt weather, a kind of efflorescence of a ſaltiſh taſte manifeſtly diſcernable upon the ſurfaces of their glaſſes; I was anſwered in the affirmative, eſpecially by the above-mentioned artificer, who having more occaſion and opportunity to take notice of ſuch things, told me, that he had by taſting found theſe exſudations ſenſibly ſaltiſh.

SECT. XIV.

AND I was the more apt to entertain the lately propoſed conjecture, becauſe of a thick glaſs cup, that I have yet by me, in the making of which, to render it the more diaphanous, I ſuppoſed an over-great proportion of ſalt had been employed. For this cup, though for a while it continued clear and intire, yet before the enſuing winter was ended, though it did not ſo crack as to fall to pieces, but ſtill retains its former ſhape, yet it was flawed with ſuch a multitude of little cracks, that at a diſtance it looks like a white, not like a cryſtalline cup.

SECT. XV.

I REMEMBER alſo, that I have ſometimes, though not often, had veſſels and other bodies of glaſs of a conſiderable thickneſs, which have of their own accord broken ſuddenly aſunder, with noiſe enough to make me take notice of it. And that this did not always happen for want of the glaſs's being gradually or ſlowly cooled, or, in the workmen's language, nealed; I was perſuaded, not only by the ſpontaneous cracking, not without a loud noiſe of a thick and empty glaſs veſſel, that had for I know not how many months been kept locked up in my ſtudy; but by the like accidents, which I after found had happened unto others. For inquiring of ſome, that made great ſtore of glaſs veſſels, as well as of others that ſold them; I learned from both, that they had ſometimes by their loſſes been made to take notice, that glaſſes, that had been long made, and kept unemployed, would break of themſelves, when there was no viſible outward agent near enough to be ſuſpected of the having broken them. And ſince this very page began to be written, I had a fair cryſtal phial, not too well ſtopped, which cracked at the thick bottom, in a glaſs-cabinet (that was fixed to a wall) where I kept that with other choice phials under lock and key; no other of the included glaſſes (full nor empty) nor yet of the external glaſſes appearing any way cracked or injured. Nay, even great and ſtrong looking-glaſſes are not quite exempted from theſe accidents. For I remember, that having purpoſely inquired of an honeſt man, that furniſhed the greateſt part of *London* with large looking glaſſes, whether he did not ſometimes find them crack, and that with noiſe; he ſhewed me divers large plates of excellent glaſs, and aſſured me, that ſometimes after they had been a good while in his ſhop, ſome of them would of themſelves, not only crack with a loud noiſe, but now and then alſo (though rarely) fly aſunder with that violence, as to break ſome of the neighbouring plates, though thick and ſtrong.

SECT. XVI.

AND having alſo a mind to inquire further, whether this diſpoſition to break, in ſome ſorts of glaſs, might not continue much longer than I had opportunity to obſerve, I addreſſed my ſelf to an ingenious maſter of a glaſs-houſe, and demanded of him, how long he had taken notice of glaſs to continue ſound and whole, and yet afterwards to break of it ſelf. He replied, that he had once a great parcel of glaſſes packed up, which not having the occaſion he expected to vend and make uſe of, lay by him for a great while; and yet when afterwards he had unpacked them, and ranged them, in a ſhort time a great many of them, amounting to about a fourth or third part of the whole number, cracked of themſelves; and when I aſked, how long the parcels had lain by, before they were opened, he replied, that it was, as he remembred, between four and five years.

SECT. XVII.

THESE inſtances, (to which I could add divers others) I have therefore mentioned, becauſe either of the two hypotheſes, in congruity whereunto they ſeem likelieſt to be intelligibly explicable, will favour the doctrine hitherto patronized. For according to the atomical theory, it may be conceived, that there is a conſtant inteſtine motion of the ſmall parts of the glaſs upon the ſcore of their conſtituent atoms, which endeavour or tend to extricate themſelves and get away, which at laſt they do, by breaking the glaſs in ſome brittle, or other fit place; where (after a multitude of encounters and evolutions) a competent number of them may happen to be got together, and find their motion (outwards) withſtood: whence may enſue ſo unequal an agitation there of the formerly coherent parts of the glaſs, as to make the more agitated ones part from them, that are leſs ſo; and conſequently crack the glaſs. To which agrees what I have often obſerved in chymical and mechanical trials made with glaſs-veſſels, that if there be any grain of ſand or gravel, or any little lump of the alkalizate

matter

matter glaſs is made of, conſpicuouſly incloſed in the ſubſtance of the veſſel, it will both be much the more apt to break, and, if it do, will almoſt always begin to crack at that place, (whence uſually as from a center ſeveral cracks go ſeveral ways;) the part of the glaſs, where the blemiſh is, being commonly of a differing texture from the reſt (as is often manifeſt to the very eye) and being by that incongruous texture diſpoſed to be put into a motion differing from, and perhaps very diſproportionate to that of the neighbouring parts.

SECT. XVIII.

I Must not here ſtay to examine, whether or no this motion of the internal parts may not (in divers caſes) be made more efficacious by the penetration of ſome ſubtile and moiſt matter into the glaſs's pores, (eſpecially the more ſuperficial ones of ſome glaſs of a looſer ſort) and ſo by degrees vitiate the texture of the body, and promoting the agitation and ſwelling of the ſaline corpuſcles, enable them to burſt the glaſs, after ſome ſuch manner, as the marchaſites I lately mentioned, came to have a vitriolate efflorescence, and even to be burſt by the operation of the air; this, I ſay, I muſt not now ſtay to examine, becauſe I would haſten to propoſe the ſecond hypotheſis, and tell you, that (elſe) we may, congruouſly to what we elſewhere diſcourſe, imagine, that in tract of time, there is produced in ſome parts of a glaſs a texture, that makes it reſiſt more than it did formerly the free paſſage of the æther, or ſome other ſubtile matter, that was accuſtomed (perhaps ſtream-like) to permeate it before; which tranſient matter now finding its paſſage obſtructed (and, perchance, almoſt quite hindered) by the vitiating of the pores of the glaſs, or ſome other (inconvenient) change of texture in it, and endeavouring to continue its wonted motion through it, does ſo ſtretch the pores, or otherwiſe offer violence to the texture of the body, that it cauſes a divulſion in the parts, which, according as it is more or leſs forcibly or ſuddenly made, does either barely crack the glaſs, or make it fly aſunder. To the precedent doctrine theſe two things agree not ill: the firſt, that glaſs is a body eaſily made electrical by rubbing, which makes it probable, that its particles may eaſily be put into motion. And the ſecond, that ſuch a divulſion may be made in glaſs by but an inequal motion between the neighbouring parts; as may appear by the chymical practice of cracking glaſſes, which they often think fit to do, only by applying a red-hot iron to the place, till it be ſufficiently heated, and whilſt it is very hot, moiſtening it with cold water (or even ſpittle) which by cooling the part, that it touched, and conſequently checking the agitation of the corpuſcles it meets there, whilſt the contiguous parts retain their former vehement agitation, occaſions a diſcontinuity or divulſion in the glaſs, ſome of whoſe parts are in ſo ſwift, and others are in ſo ſlow a motion.

SECT. XIX.

And on this occaſion I ſhall add chiefly, becauſe I would not pretermit ſo conſiderable a phænomenon, that even when glaſs ſeems to have loſt the degree of heat, that one would think neceſſary to have its ſhape or bigneſs ſenſibly altered; there may remain yet ſo much agitation in the minute parts, as, when they are modified by the air, by the cold, or by ſome other) inviſible agent, to make them alter the bulk or ſhape of the whole veſſel they compoſe; and that (which one would not expect) by enlarging the veſſel, at leaſt if we allow not in the caſe any change of figure: for it has often been obſerved in thoſe glaſs-houſes, where they work white glaſſes, as they call thoſe, that are pure and clear, that when they have blown glaſſes into a mold, to give them more exactly the deſired ſhape and ſize, theſe glaſſes, when they are cold, cannot well be put again into the ſame mold they were blown in, and require, that the cells of garde-phials, that are to receive them, be made a little larger: which obſervation an eminent artificer of my acquaintance, that gets conſiderably by fitting fine glaſſes to caſes, has much confirmed to me by his complaints of the inconvenience, eaſy to be incurred, by the not knowing, or not remembering ſo unlikely an effect of the cooling of glaſs. But I muſt not proſecute the conſideration of theſe, and the like phænomena, nor examine, which of the preceding explications is preferable, having mentioned them, as I was ſaying, chiefly to ſhew, that, which of them ſoever we pitch upon, it will argue an inteſtine motion in the corpuſcles of the glaſs, which motion we ſhall think may be very ſlow, if we conſider how long a time it is on ſome occaſions, in producing its effects, before it brings them to be diſcernable to our ſenſes.

SECT. XX.

Having thus made it probable, that among the parts of ſuch ſolid bodies, as I have hitherto inſtanced in, there may not be ſuch a perfect reſt, as is generally believed; it will, I ſuppoſe, be expected, that I ſhould now draw this conſequence from what has been ſaid, that there is no ſuch thing as abſolute reſt in nature. But ſince at my firſt mentioning this paradox to you, I propoſed it but as problematical, and ſince I conſider, that we are not yet ſure, but that though many of the parts of ſolid bodies may not be always moveleſs, yet ſome others of them may ſometimes, for a while at leaſt, be at perfect reſt: I ſhall conclude, as I began, and without reſolutely denying, that there can be any ſuch thing *in rerum naturâ*, as abſolute reſt, I ſhall content my ſelf to ſay, that it is not either abſurd to doubt, whether there be or no; nor improbable to think, that there is not, ſince we have not found it in thoſe very bodies, where, with the greateſt likelihood, it might have been expected.

THE SCEPTICAL CHYMIST: OR Chymico-Phyſical Doubts and Paradoxes, TOUCHING THE EXPERIMENTS,

Whereby vulgar Spagyriſts are wont to endeavour to evince their Salt, Sulphur and Mercury, to be the true Principles of Things.

To which, in this Edition, are ſubjoined divers Experiments and Notes about the Produciblenes of Chymical Principles.

A PREFACE INTRODUCTORY to the following Treatiſe.

TO give the reader an account, why the following treatiſe is ſuffered to paſs abroad ſo maimed and imperfect, I muſt inform him, that it is now long ſince, that to gratify an ingenious gentleman, I ſet down ſome of the reaſons, that kept me from fully acquieſcing either in the peripatetical, or in the chymical doctrine of the material principles of mixed bodies. This diſcourſe, ſome years after, falling into the hands of ſome learned men, had the good luck to be ſo favourably received, and advantageouſly ſpoken of by them, that having had more than ordinary invitations given me to make it publick, I thought fit to review it, that I might retrench ſome things, that ſeemed not ſo fit to be ſhewn to every reader, and ſubſtitute ſome of thoſe other things, that occurred to me of the trials and obſervations I had ſince made. What became of my papers, I elſewhere mention in a preface, where I complain of it; but ſince I writ that, I found many ſheets, that belonged to the ſubjects I am now about to diſcourſe of. Wherefore, ſeeing that I had then in my hands as much of the firſt Dialogue, as was requiſite to ſtate the caſe, and ſerve for an Introduction as well to the Conference betwixt *Carneades* and *Eleutherius*, as to ſome other Dialogues, which for certain reaſons are not herewith publiſhed, I reſolved to ſupply, as well as I could, the contents of a paper belonging to the ſecond of the following diſcourſes, which I could not poſſibly retrieve, though it were the chief of them all. And having once more tried the opinion of friends, but not the ſame, about this imperfect work, I found it ſuch, that I was content, in compliance with their deſires, that not only it ſhould be publiſhed, but that it ſhould be publiſhed as ſoon as conveniently might be. I had, indeed, all along the Dialogues ſpoken of my ſelf, as of a third perſon; for they containing diſcourſes, which were among the firſt treatiſes, that I ventured long ago to write of matters philoſophical, I had reaſon to deſire, with the painter, to *latere pone tabulam*, and hear what men would ſay of them, before I owned my ſelf to be their author. But, beſides, that now I find, it is not unknown to many, who it is, that writ them, I am made to believe, that it is not inexpedient, they ſhould be known to come from a perſon altogether a ſtranger to chymical affairs. And I made the leſs ſcruple to let them come abroad uncompleated, partly, becauſe my affairs and pre-ingagements to publiſh divers other treatiſes, allowed me ſmall hopes of being able in a great while to compleat thoſe Dialogues. And partly becauſe I am not unapt to think, that they may come abroad ſeaſonably enough, though not for the author's reputation, yet for other purpoſes. For I obſerve, that of late chymiſtry begins, as indeed it deſerves, to be cultivated by learned men, who before deſpiſed it; and to be pretended to by many, who never cultivated it, that they may be thought not to be ignorant of it: whence it is come to paſs, that divers chymical notions about matters philoſophical are taken for granted and employed, and ſo adopted by very eminent writers both naturaliſts and phyſicians. Now this, I fear, may prove ſomewhat prejudicial to the advancement of ſolid philoſophy: for though I am a great lover of chymical experiments, and though I have no mean eſteem of divers chymical remedies, yet I diſtinguiſh theſe from their notions about the cauſes of things and their manner of generation. And, for aught I can hitherto diſcern, there are a thouſand phænomena in nature, beſides a multitude

titude of accidents relating to the human body, which will ſcarcely be clearly and ſatisfactorily made out by them, that confine themſelves to deduce things from ſalt, ſulphur and mercury, and the other notions peculiar to the chymiſts, without taking much more notice than they are wont to do, of the motions and figures of the ſmall parts of matter, and the other more catholick and fruitful affections of bodies. Wherefore it will not, perhaps, be now unſeaſonable to let our *Carneades* warn men, not to ſubſcribe to the grand doctrine of the chymiſts, touching their three hypoſtatical principles, till they have a little examined it, and conſidered, how they can clear it from his objections, divers of which, it is like, they may never have thought on; ſince a chymiſt ſcarce would, and none but a chymiſt could propoſe them. I hope alſo, it will not be unacceptable to ſeveral ingenious perſons, who are unwilling to determine of any important controverſy, without a previous conſideration of what may be ſaid on both ſides, and yet have greater deſires to underſtand chymical matters, than opportunities of learning them, to find here together, beſides ſeveral experiments of my own, purpoſely made to illuſtrate the doctrine of the elements, divers others, ſcarce to be met with, otherwiſe than ſcattered among many chymical books; and to find theſe aſſociated experiments ſo delivered, as that an ordinary reader, if he be but acquainted with the uſual chymical terms, may eaſily enough underſtand them; and even a wary one may ſafely rely on them. Theſe things I add, becauſe a perſon, any thing verſed in the writings of chymiſts cannot but diſcern by their obſcure, ambiguous, and almoſt ænigmatical way of expreſſing what they pretend to teach, that they have no mind to be underſtood at all, but by the ſons of art (as they call them) nor to be underſtood even by theſe, without difficulty and hazardous trials. Inſomuch that ſome of them ſcarce ever ſpeak ſo candidly, as when they make uſe of that known chymical ſentence; *ubi palam locuti ſumus, ibi nihil diximus.* And, as the obſcurity of what ſome writers deliver makes it very difficult to be underſtood; ſo the unfaithfulneſs of too many others makes it unfit to be relied on. For though unwillingly, yet I muſt for the truth's ſake, and the reader's, warn him not to be forward to believe chymical experiments, when they are ſet down only by way of preſcriptions, and not of relations; that is, unleſs he, that delivers them, mentions his doing it upon his own particular knowledge, or upon the relation of ſome credible perſon, avowing it upon his own experience. For I am troubled, I muſt complain, that even eminent writers, both phyſicians and philoſophers, whom I can eaſily name, if it be required, have of late ſuffered themſelves to be ſo far impoſed upon, as to publiſh and build upon chymical experiments, which queſtionleſs they never tried; for if they had, they would, as well as I, have found them not to be true. And indeed, it were to be wiſhed, that now, that thoſe begin to quote chymical experiments, that are not themſelves acquainted with chymical operations, men would leave off that indefinite way of vouching, the chymiſts ſay this, or the chymiſts affirm that; and would rather, for each experiment they alledge, name the author or authors, upon whoſe credit they relate it: for by this means, they would ſecure themſelves from the ſuſpicion of falſhood (to which the other practice expoſes them) and they would leave the reader to judge of what is fit for him to believe of what is delivered, whilſt they employ not their own great names to countenance doubtful relations; and they will alſo do juſtice to the inventors or publiſhers of the true experiments, as well as upon the obtruders of falſe ones. Whereas, by that general way of quoting the chymiſts, the candid writer is defrauded of the particular praiſe, and the impoſtor eſcapes the perſonal diſgrace, that is due to him.

THE remaining part of this Preface muſt be imployed in ſaying ſomething for *Carneades*, and ſomething for my ſelf.

AND firſt, *Carneades* hopes, that he will be thought to have diſputed civilly and modeſtly enough for one, that was to play the antagoniſt and the ſceptick: and if he any where ſeems to ſlight his adverſaries tenets and arguments, he is willing to have it looked upon as what he was induced to, not ſo much by his opinion of them, as the examples of *Themiſtius* and *Philoponus*, and the cuſtom of ſuch kind of diſputes.

NEXT, in caſe that ſome of his arguments ſhall not be thought of the moſt cogent ſort, that may be, he hopes it will be conſidered, that it ought not to be expected, that they ſhould be ſo. For his part being chiefly but to propoſe doubts and ſcruples, he does enough, if he ſhews, that his adverſaries arguments are not ſtrongly concluding, though his own be not ſo neither. And if there ſhould appear any diſagreement betwixt the things he delivers in divers paſſages, he hopes it will be conſidered, that it is not neceſſary, that all the things a ſceptick propoſes ſhould be conſonant; ſince it being his work to ſuggeſt doubts againſt the opinion he queſtions, it is allowable for him to propoſe two or more ſeveral hypotheſes about the ſame thing; and to ſay, that it may be accounted for this way, or that way, or the other way, though theſe ways be perhaps inconſiſtent among themſelves. Becauſe it is enough for him, if either of the propoſed hypotheſes be but as probable as that he calls in queſtion. And if he propoſe many, that are each of them probable, he does the more ratify his doubts, by making it appear the more difficult to be ſure, that that way, which they all differ from, is the true. And our *Carneades*, by holding the negative, has this advantage, that if among all the inſtances he brings to invalidate the vulgar doctrine of thoſe he diſputes with, any one be irrefragable, that alone is ſufficient to overthrow a doctrine, which univerſally aſſerts what he oppoſes. For it cannot be true, that all bodies whatſoever, that are reckoned among the perfectly mixt ones, are compounded of ſuch a determinate number of ſuch or ſuch ingredients, in caſe any one ſuch body can be pro-

duced

duced, that is not ſo compounded; and he hopes too, that accurateneſs will be the leſs expected from him, becauſe his undertaking obliges him to maintain ſuch opinions in chymiſtry, and that chiefly by chymical arguments, as are contrary to the very principles of the chymiſts, from whoſe writings it is not therefore like he ſhould receive any intentional aſſiſtance, except from ſome paſſages of the bold and ingenious *Helmont*, with whom he yet diſagrees in many things, (which reduce him to explicate divers chymical phænomena, according to other notions;) and of whoſe ratiocinations, not only ſome ſeem very extravagant, but even the reſt are not wont to be as conſiderable as his experiments. And though it be true indeed, that ſome Ariſtotelians have occaſionally written againſt the chymical doctrine he oppugns, yet ſince they have done it according to their principles, and ſince our *Carneades* muſt as well oppoſe their hypotheſis as that of the Spagyriſt, he was fain to fight his adverſaries with his own weapons, thoſe of the Peripatetick being improper, if not hurtful, for a perſon of his tenets; beſides that thoſe Ariſtotelians, (at leaſt thoſe he met with,) that have written againſt the chymiſts, ſeem to have had ſo little experimental knowledge in chymical matters, that by their frequent miſtakes and unſkilful way of oppugning, they have too often expoſed themſelves to the deriſion of their adverſaries, for writing ſo confidently againſt what they appear ſo little to underſtand.

And laſtly, *Carneades* hopes, he ſhall do the ingenious this piece of ſervice, that by having thus drawn the chymiſts doctrine out of their dark and ſmoky laboratories, and both brought it into the open light, and ſhewn the weakneſs of their proofs, that have hitherto been wont to be brought for it, either judicious men ſhall henceforth be allowed calmly and after due information to diſbelieve it, or thoſe abler chymiſts, that are zealous for the reputation of it, will be obliged to ſpeak plainer than hitherto has been done, and maintain it by better experiments and arguments than thoſe *Carneades* hath examined: ſo that he hopes the curious will one way or other derive either ſatisfaction or inſtruction from his endeavours. And as he is ready to make good the profeſſion he makes in the cloſe of his diſcourſe, of being ready to be better informed, ſo he expects either to be indeed informed, or to be let alone. For though, if any truly knowing chymiſts ſhall think fit in a civil and rational way to ſhew him any truth, touching the matter in diſpute, that he yet diſcerns not, *Carneades* will not refuſe either to admit, or to own a conviction; yet if any impertinent perſon ſhall, either to get himſelf a name, or for what other end ſoever, wilfully or careleſly miſtake the ſtate of the controverſy, or the ſenſe of his arguments, or ſhall rail inſtead of arguing, as hath been done of late, in print, by divers chymiſts *; or laſtly, ſhall write againſt them in a canting way, I mean, ſhall expreſs himſelf in ambiguous or obſcure terms, or argue from experiments not intelligibly enough delivered, *Carneades* profeſſes, that he values his time ſo much, as not to think the anſwering ſuch trifles worth the loſs of it.

And now having ſaid thus much for *Carneades*, I hope the reader will give me leave to ſay ſomething for my ſelf.

And firſt, if ſome moroſe readers ſhall find fault with my having made the interlocutors upon occaſion compliment with one another, and that I have almoſt all along written theſe Dialogues, in a ſtyle more faſhionable than that of meer ſcholars is wont to be, I hope I ſhall be excuſed by them, that ſhall conſider, that to keep a due decorum in the diſcourſes, it was fit, that in a book written by a gentleman, and wherein only gentlemen are introduced as ſpeakers, the language ſhould be more ſmooth, and the expreſſions more civil, than is uſual in the more ſcholaſtick way of writing. And indeed, I am not ſorry to have this opportunity of giving an example, how to manage even diſputes with civility; whence, perhaps, ſome readers will be aſſiſted to diſcern a difference betwixt bluntneſs of ſpeech and ſtrength of reaſon, and find, that a man may be a champion for truth, without being an enemy to civility; and may confute an opinion without railing at them that hold it; to whom, he that deſires to convince and not to provoke them, muſt make ſome amends by his civility to their perſons for his ſeverity to their miſtakes; and muſt ſay as little elſe as he can, to diſpleaſe them, when he ſays, that they are in an error.

But, perhaps, other readers will be leſs apt to find fault with the civility of my diſputants, than the chymiſts will be, upon the reading of ſome paſſages of the following Dialogue, to accuſe *Carneades* of aſperity. But, if I have made my Sceptick ſometimes ſpeak ſlightingly of the opinions he oppoſes, I hope it will not be found, that I have done any more, than became the part he was to act, of an opponent: eſpecially, if what I have made him ſay, be compared with what the prince of the Roman orators himſelf makes both great perſons and friends ſay of one another's opinions, in his excellent Dialogues, *de naturâ Deorum*: and I ſhall ſcarce be ſuſpected of partiality in the caſe, by them, that take notice, that there is full as much (if not far more) liberty of ſlighting their adverſaries tenets, to be met with in the diſcourſes of thoſe, with whom *Carneades* diſputes. Nor need I make the interlocutors ſpeak otherwiſe than freely in a Dialogue, wherein it was ſufficiently intimated, that I meant not to declare my own opinion of the arguments propoſed, much leſs of the whole controverſy it ſelf, otherwiſe than as it may by an attentive reader be gueſſed at by ſome paſſages of *Carneades*; (I ſay, ſome paſſages, becauſe I make not all, that he ſays, eſpecially in the heat of diſputation, mine,) partly in this diſcourſe, and partly in ſome other † Dialogues betwixt the,

* *G.* and *F.* and *H.* and others, in their books againſt one another.

† The Dialogues here meant are thoſe about heat, fire, flame, &c. (ſeen by two Secretaries of the Royal Society) that the author ſomewhere complains to have been miſſing, with other things of his, preſently after the haſty removal of his goods by night in the great fire of *London*.

the ſame ſpeakers (though they treat not immediately of the elements) which have long lain by me, and expect the entertainment, that theſe preſent diſcourſes will meet with. And indeed they will much miſtake me, that ſhall conclude from what I now publiſh, that I am at defiance with chymiſtry, or would make my readers ſo. I hope the *ſpecimina* I have lately publiſhed of an attempt to ſhew the uſefulneſs of chymical experiments to contemplative philoſophers, will give thoſe, that read them, other thoughts of me, and I had a deſign (but wanted opportunity) to publiſh with theſe papers an eſſay I have lying by me, the greater part of which is apologetical for one ſort of chymiſts. And at leaſt, as for thoſe, that know me, I hope the pains I have taken in the fire will both convince them, that I am far from being an enemy to the chymiſts art, (though I am no friend to many, that diſgrace it by profeſſing it,) and perſuade them to beleive me, when I declare, that I diſtinguiſh betwixt thoſe chymiſts, that are either cheats, or but laborants, and the true *adepti*; by whom, could I enjoy their converſation, I would both willingly and thankfully be inſtructed; eſpecially concerning the nature and generation of metals: and poſſibly, thoſe, that know how little I have remitted of my former addictedneſs to make chymical experiments, will eaſily believe, that one of the chief deſigns of this ſceptical diſcourſe was, not ſo much to diſcredit chymiſtry, as to give an occaſion and a kind of neceſſity to the more knowing artiſts, to lay aſide a little of their over-great reſervedneſs, and either explicate or prove the chymical theory better than ordinary chymiſts have done, or, by enriching us with ſome of their nobler ſecrets, to evince, that their art is able to make amends even for the deficiences of their theory. And thus much I ſhall make bold to add, that we ſhall much undervalue chymiſtry, if we imagine, that it cannot teach us things far more uſeful, not only to phyſick, but to philoſophy, than thoſe, that are hitherto known to vulgar chymiſts. And yet, as for inferiour Spagyriſts themſelves, they have, by their labours, deſerved ſo well of the common wealth of learning, that methinks it is pity they ſhould ever miſs the truth, which they have ſo induſtriouſly ſought. And though I be no admirer of the theorical part of their art, yet my conjectures will much deceive me, if the practical part be not hereafter much more cultivated, than hitherto it has been, and do not both employ philoſophy and philoſophers, and hope to make men ſuch. Nor would I, that have been diverted by other ſtudies as well as affairs, be thought to pretend being a profound Spagyriſt, by finding ſo many faults in the doctrine, wherein the generality of chymiſts ſcruple not to acquieſce: for beſides that it is moſt commonly far eaſier to frame objections againſt any propoſed hypotheſis, than to propoſe an hypotheſis not liable to objections (beſides this, I ſay) it is no ſuch great matter, if whereas beginners in chymiſtry are commonly at once imbued with the theory and operations of their profeſſion, I, who had the good fortune to learn the operations from illiterate perſons, upon whoſe credit I was not tempted to take up any opinion about them, ſhould conſider things with leſs prejudice, and conſequently with other eyes than the generality of learners; and ſhould be more diſpoſed to accommodate the phænomena, that occurred to me, to other notions than to thoſe of the Spagyriſts. And having at firſt entertained a ſuſpicion, that the vulgar principles were leſs general and comprehenſive, or leſs conſiderately deduced from chymical operations, than was believed, it was not uneaſy for me both to take notice of divers phænomena, over-looked by prepoſſeſt perſons, that ſeemed not to ſuit ſo well with the hermetical doctrine; and to deviſe ſome experiments likely to furniſh me with objections againſt it, not known to many, that having practiſed chymiſtry longer, perchance, than I have yet lived, may have far more experience, than I, of particular proceſſes.

To conclude, whether the notions I have propoſed, and the experiments I have communicated, be conſiderable, or not, I willingly leave others to judge; and this only I ſhall ſay for myſelf, that I have endeavoured to deliver matters of fact ſo faithfully, that I may as well aſſiſt the leſs ſkilful readers to examine the chymical hypotheſis, as provoke the ſpagyrical philoſophers to illuſtrate it: which if they do, and that either the chymical opinion, or the peripatetick, or any other theory of the elements differing from that I am moſt inclined to, ſhall be intelligibly explicated, and duly proved to me; what I have hitherto diſcourſed will not hinder it from making a proſelyte of a perſon, that loves fluctuation of judgment little enough to be willing to be eaſed of it by any thing but error.

Advertiſement.

THE reader is deſired to take notice, that, as the date of the licence witneſſes, this book ſhould have been printed long ago, and there has been a miſtake in the bottom of the title-page, where the year 1680. has been put inſtead of the year 1679, in which it was really printed off, though not publickly expoſed to ſale, till the beginning of this month of *January* 1678-79.

PHYSIOLOGICAL CONSIDERATIONS

TOUCHING

The Experiments wont to be employed to evince, either the four Peripatetick Elements, or the three chymical Principles of mixt Bodies.

Part of the Firſt Dialogue.

I PERCEIVE, that divers of my friends have thought it very ſtrange to hear me ſpeak ſo irreſolvedly, as I have been wont to do, concerning thoſe things, which ſome take to be the elements, and others to be the principles of all mixed bodies. But I bluſh not to acknowledge, that I much leſs ſcruple to confeſs, that I doubt, when I do ſo, than to profeſs, that I know what I do not: and I ſhould have much ſtronger expectations than I dare yet entertain, to ſee philoſophy ſolidly eſtabliſhed, if men would more carefully diſtinguiſh thoſe things, that they know, from thoſe, that they ignore or do but think, and then explicate clearly the things they conceive they underſtand, acknowledge ingenuouſly what it is they ignore, and profeſs ſo candidly their doubts, that the induſtry of intelligent perſons might be ſet on work to make further enquiries, and the eaſineſs of leſs diſcerning men might not be impoſed on. But becauſe a more particular account will probably be expected of my unſatisfiedneſs, not only with the peripatetick, but with the chymical doctrine of the primitive ingredients of bodies; it may poſſibly ſerve to ſatisfy others of the excuſeableneſs of my diſſatisfaction, to peruſe the enſuing relation of what paſſed a while ſince at a meeting of perſons of ſeveral opinions, in a place that need not here be named; where the ſubject, whereof we have been ſpeaking, was amply and variouſly diſcourſed of.

IT was on one of the faireſt days of this ſummer, that the inquiſitive *Eleutherius* came to invite me to make a viſit with him to his friend *Carneades*. I readily conſented to this motion, telling him, that if he would but permit me to go firſt and make an excuſe at a place not far off, where I had at that hour appointed to meet, but not about a buſineſs either of moment, or that could not well admit of a delay, I would preſently wait on him, becauſe of my knowing *Carneades* to be ſo converſant with nature and with furnaces, and ſo unconfined to vulgar opinions, that he would probably, by ſome ingenious paradox or other, give our minds at leaſt a pleaſing exerciſe, and perhaps enrich them with ſome ſolid inſtruction. *Eleutherius* then firſt going with me to the place where my apology was to be made, I accompanied him to the lodging of *Carneades*, where when we were come, we were told by the ſervants, that he was retired with a couple of friends (whoſe names they alſo told us) to one of the arbours in his garden, to enjoy under its cool ſhades a delightful protection from the yet troubleſome heat of the ſun.

ELEUTHERIUS being perfectly acquainted with that garden, immediately led me to the arbour, and relying on the intimate familiarity, that had been long cheriſhed betwixt him and *Carneades*; in ſpight of my reluctancy to what might look like an intruſion upon his privacy, drawing me by the hand, he abruptly entered the arbour, where we found *Carneades*, *Philoponus*, and *Themiſtius*, ſitting cloſe about a little round table, on which, beſides paper, pen, and ink, there lay two or three open books. *Carneades* appeared not at all troubled at this ſurpriſe, but riſing from the table, received his friend with open looks and arms, and welcoming me alſo with his wonted freedom and civility, invited us to reſt our ſelves by him; which, as ſoon as we had exchanged with his two friends (who were ours alſo) the civilities accuſtomed on ſuch occaſions, we did. And he, preſently after we had ſeated our ſelves, ſhutting the books that lay open, and turning to us with a ſmiling countenance, ſeemed ready to begin ſome ſuch unconcerning diſcourſe, as is wont to paſs, or rather waſte the time in promiſcuous companies.

BUT *Eleutherius* gueſſing at what he meant to do, prevented him by telling him, I perceive, *Carneades*, by the books, that you have been now ſhutting, and much more by the poſture, wherein I found perſons ſo qualified to diſcourſe of ſerious matters, and ſo accuſtomed to do it, that you three were, before our coming, ingaged in ſome philoſophical conference; which I hope you will either proſecute, and allow us to be partakers of, in recompence of the freedom we have uſed in preſuming to ſurpriſe you, or elſe give us leave to repair the injury we ſhould otherwiſe do you, by leaving you to the freedom we have interrupted, and puniſhing our ſelves for our boldneſs, by depriving our ſelves of the happineſs of your company. With theſe laſt words he and I roſe up, as if we meant to be gone; but *Carneades* ſuddenly laying hold on his arm, and ſtopping him by it, ſmilingly told him, we are not ſo forward to loſe good company as you ſeem to imagine; eſpecially ſince you are pleaſed to be preſent at what we ſhall ſay, about ſuch a ſubject as that you found us conſidering. For that being the number of the elements, principles, or material ingredients of bodies, is an enquiry, whoſe truth is of that importance, and of that difficulty, that it may as well deſerve, as require, to be ſearched into by ſuch ſkilful indagators of nature, as your ſelves. And therefore we ſent to invite the bold and acute *Leucippus* to lend us ſome light by his atomical

para-

paradox, upon which we expected ſuch pregnant hints, that it was not without a great deal of trouble, that we had lately word brought us, that he was not to be found; and we had likewiſe begged the aſſiſtance of your preſence and thoughts, had not the meſſenger we employed to *Leucippus* informed us, that as he was going, he ſaw you both paſs by towards another part of the town; and this fruſtrated expectation of *Leucippus* his company, who told me but laſt night, that he would be ready to give me a meeting where I pleaſed to-day, having very long ſuſpended our conference about the freſhly-mentioned ſubject, it was ſo newly begun when you came in, that we ſhall ſcarce need to repeat any thing, to acquaint you with what had paſſed betwixt us before your arrival; ſo that I cannot but look upon it as a fortunate accident, that you ſhould come ſo ſeaſonably, to be not hearers alone, but, we hope, interlocutors at our conference. For we ſhall not only allow of your preſence at it, but deſire your aſſiſtance, in it; which I add, both for other reaſons, and becauſe though theſe learned gentlemen (ſays he, turning to his two friends) need not fear to diſcourſe before any auditory, provided it be intelligent enough to underſtand them, yet for my part, (continues he with a new ſmile,) I ſhall not dare to vent my unpremeditated thoughts before two ſuch criticks, unleſs, by promiſing to take your turns of ſpeaking, you will allow me mine of quarrelling with was has been ſaid. He and his friends added divers things to convince us, that they were both deſirous, that we ſhould hear them, and reſolved againſt our doing ſo, unleſs we allowed them ſometimes to hear us. *Eleutherius*, after having a while fruitleſsly endeavoured to obtain leave to be ſilent, promiſed he would not be ſo always, provided, that he were permitted, according to the freedom of his genius and principles, to ſide with one of them in the managing of one argument, and, if he ſaw cauſe, with his antagoniſt, in the proſecution of another, without being confined to ſtick to any one party or opinion, which was after ſome debate accorded him. But I, conſcious to my own diſabilities, told them reſolutely, that I was as much more willing, as more fit, to be a hearer than a ſpeaker, among ſuch knowing perſons, and on ſo abſtruſe a ſubject. And that therefore I beſeeched them, without neceſſitating me to proclaim my weakneſſes, to allow me to leſſen them, by being a ſilent auditor of their diſcourſes: to ſuffer me to be at which, I could preſent them no motive, ſave that their inſtructions would make them in me a more intelligent admirer. I added, that I deſired not to be idle, whilſt they were employed, but would, if they pleaſed, by writing down in ſhort hand what ſhould be delivered, preſerve diſcourſes, that I knew would merit to be laſting. At firſt, *Carneades* and his two friends utterly rejected this motion; and all that my reſoluteneſs to make uſe of my ears, not tongue, at their debates, could do, was to make them acquieſce in the propoſition of *Eleutherius*, who thinking himſelf concerned, becauſe he brought me thither, to afford me ſome faint aſſiſtance, was content, that I ſhould regiſter their arguments, that I might be the better able, after the concluſion of their conference, to give them my ſenſe upon the ſubject of it, (the number of elements or principles) which he promiſed I ſhould do at the end of the preſent debates, if time would permit, or elſe at our next meeting. And this being by him undertaken in my name, though without my conſent, the company would by no means receive my proteſtation againſt it, but caſting, all at once, their eyes on *Carneades*, they did by that, and their unanimous ſilence, invite him to begin; which (after a ſhort pauſe, during which he turned himſelf to *Eleutherius* and me) he did in this manner.

NOTWITHSTANDING the ſubtile reaſonings I have met with in the books of the Peripateticks, and the pretty experiments, that have been ſhewed me in the laboratories of chymiſts, I am of ſo diffident, or dull a nature, as to think, that if neither of them can bring more cogent arguments to evince the truth of their aſſertion than are wont to be brought; a man may rationally enough retain ſome doubts concerning the very number of thoſe material ingredients of mixt bodies, which ſome would have us call elements, and others principles. Indeed, when I conſidered, that the tenets concerning the elements are as conſiderable amongſt the doctrines of natural philoſophy, as the elements themſelves are among the bodies of the univerſe, I expected to find thoſe opinions ſolidly eſtabliſhed, upon which ſo many others are ſuperſtructed. But when I took the pains impartially to examine the bodies themſelves, that are ſaid to reſult from the blended elements, and to torture them into a confeſſion of their conſtituent principles, I was quickly induced to think, that the number of the elements has been contended about by philoſophers with more earneſtneſs than ſucceſs. This unſatisfiedneſs of mine has been much wondered at by theſe two gentlemen, (at which words he pointed at *Themiſtius* and *Philoponus*) who, though they differ almoſt as much betwixt themſelves about the queſtion we are to conſider, as I do from either of them, yet they both agree very well in this, that there is a determinate number of ſuch ingredients as I was juſt now ſpeaking of, and that what that number is, I ſay not, may be (for what may not ſuch as they perſuade?) but is wont to be clearly enough demonſtrated both by reaſon and experience. This has occaſioned our preſent conference. For our diſcourſe this afternoon having fallen from one ſubject to another, and at length ſettled on this, they proffered to demonſtrate to me, each of them the truth of his opinion, out of both the topicks, that I have freſhly named. But on the former (that of reaſon ſtrictly ſo taken) we declined inſiſting at the preſent, leſt we ſhould not have time enough before ſupper to go through the reaſons and experiments too. The latter of which we unanimouſly thought the moſt requiſite to be ſeriouſly examined. I muſt deſire you then to take notice gentlemen, (continued *Carneades*) that my preſent buſineſs

doth not oblige me ſo to declare my own opinion on the ſubject in queſtion, as to aſſert or deny the truth either of the peripatetick, or the chymical doctrine, concerning the number of the elements; but only to ſhew you, that neither of theſe doctrines hath been ſatisfactorily proved by the arguments commonly alledged on its behalf. So that if I really diſcern (as, perhaps, I think I do) that there may be a more rational account than ordinary given of one of theſe opinions, I am left free to declare my ſelf of it, notwithſtanding my preſent engagement; it being obvious to all your obſervation, that a ſolid truth may be generally maintained by no other, than incompetent arguments. And to this declaration I hope it will be needleſs to add, that my taſk obliges me not to anſwer the arguments, that may be drawn either for *Themiſtius* or *Philoponus*'s opinion from the topick of reaſon, as expoſed to experiments; ſince it is theſe only, that I am to examine, and not all theſe neither, but ſuch of them alone, as either of them ſhall think fit to inſiſt on, and as have hitherto been wont to be brought either to prove, that it is the four peripatetick elements, or that it is the three chymical principles, that all compounded bodies conſiſt of. Theſe things (adds *Carneades*) I thought my ſelf obliged to premiſe, partly leſt you ſhould do theſe gentlemen (pointing at *Themiſtius* and *Philoponus*, and ſmiling on them) the injury of meaſuring their parts by the arguments they are ready to propoſe, the laws of our conference confining them to make uſe of thoſe, that the vulgar of philoſophers (for even of them there is a vulgar) has drawn up to their hands; and partly, that you ſhould not condemn me of preſumption for diſputing againſt perſons over whom I can hope for no advantage, that I muſt not derive from the nature, or rules of our controverſy, wherein I have but a negative to defend, and wherein too I am like on ſeveral occaſions to have the aſſiſtance of one of my diſagreeing adverſaries againſt the other.

PHILOPONUS and *Themiſtius* ſoon returned this compliment with civilities of the like nature, in which *Eleutherius* perceiving them engaged, to prevent the further loſs of that time, of which they were not like to have very much to ſpare, he minded them, that their preſent buſineſs was not to exchange compliments, but arguments: and then addreſſing his ſpeech to *Carneades*, I eſteemed it no ſmall happineſs (ſays he) that I am come here ſo luckily this evening. For I have been long diſquieted with doubts concerning this very ſubject, which you are now ready to debate. And ſince a queſtion of this importance is to be now diſcuſſed by perſons, that maintain ſuch variety of opinions concerning it, and are both ſo able to inquire after truth, and ſo ready to imbrace it by whomſoever and on what occaſion ſoever it is preſented them; I cannot but promiſe my ſelf, that I ſhall, before we part, either loſe my doubts or the hopes of ever finding them reſolved. *Eleutherius* pauſed not here; but, to prevent their anſwer, added almoſt in the ſame breath, And I am not a little pleaſed to find, that you are reſolved, on this occaſion, to inſiſt rather on experiments than ſyllogiſms. For I, and no doubt you, have long obſerved, that thoſe dialectical ſubtleties, that the ſchoolmen too often employ about phyſiological myſteries, are wont much more to declare the wit of him, that uſes them, than increaſe the knowledge or remove the doubts of ſober lovers of truth. And ſuch captious ſubtleties do indeed often puzzle, and ſometimes ſilence men, but rarely ſatisfy them; being like the tricks of jugglers, whereby men doubt not but they are cheated, though oftentimes they cannot declare by what ſlights they are impoſed on. And therefore I think you have done very wiſely to make it your buſineſs to conſider the phænomena relating to the preſent queſtion, which have been afforded by experiments, eſpecially ſince it might ſeem injurious to our ſenſes, by whoſe mediation we acquire ſo much of the knowledge we have of things corporal, to have recourſe to far-fetched and abſtracted ratiocinations, to know what are the ſenſible ingredients of thoſe ſenſible things, that we daily ſee and handle, and are ſuppoſed to have the liberty to untwiſt (if I may ſo ſpeak) into the primitive bodies they conſiſt of. He annexed, that he wiſhed therefore they would no longer delay his expected ſatisfaction, if they had not, as he feared they had, forgotten ſomething preparatory to their debate; and that was to lay down, what ſhould be all along underſtood by the word principle or element. *Carneades* thanked him for his admonition, but told him, that they had not been unmindful of ſo requiſite a thing. But that being gentlemen, and very far from the litigious humour of loving to wrangle about words, or terms, or notions as empty, they had, before his coming in, readily agreed promiſcuouſly to uſe, when they pleaſed, elements and principles, as terms equivalent; and to underſtand both by the one and the other thoſe primitive and ſimple bodies, of which the mixt ones are ſaid to be compoſed, and into which they are ultimately reſolved. And upon the ſame account (he added) we agreed to diſcourſe of the opinions to be debated, as we have found them maintained by the generality of the aſſertors of the four elements of the one party, and of thoſe, that receive the three principles on the other, without tying our ſelves to inquire ſcrupulouſly, what notion either *Ariſtotle* or *Paracelſus*, or this or that interpreter, or follower of either of thoſe great perſons, framed of elements or principles; our deſign being to examine, not what theſe or thoſe writers thought or taught, but what we find to be the obvious and moſt general opinion of thoſe, who are willing to be accounted favourers of the peripatetick or chymical doctrine, concerning this ſubject.

I SEE not (ſays *Eleutherius*) why you might not immediately begin to argue, if you were but agreed which of your two friendly adverſaries ſhall be firſt heard. And it being quickly reſolved on, that *Themiſtius* ſhould firſt propoſe the proofs for his opinion, becauſe it was the ancienter, and the more general, he made not the company expect long before he thus addreſſed himſelf to *Eleutherius*, as to the perſon leaſt intereſted in the diſpute.

IF you have taken ſufficient notice of the late confeſſion, which was made by *Carneades*, and which (though his civility dreſſed it up in complemental expreſſions) was exacted of him by his juſtice, I ſuppoſe you will be eaſily made ſenſible, that I engage in this controverſy with great and peculiar diſadvantages, beſides thoſe, which his parts and my perſonal diſabilities would bring to any other cauſe, to be maintained by me againſt him. For he juſtly apprehending the force of truth, though ſpeaking by no better a tongue than mine, has made it the chief condition of our duel, that I ſhould lay aſide the beſt weapons I have, and thoſe I can beſt handle; whereas, if I were allowed the freedom, in pleading for the four elements, to employ the arguments ſuggeſted to me by reaſon to demonſtrate them, I ſhould almoſt as little doubt of making you a proſelyte to thoſe unſever'd teachers, Truth and *Ariſtotle*, as I do of your candour and your judgment. And I hope you will however conſider, that that great favourite and interpreter of nature, *Ariſtotle*, who was (as his *Organum* witneſſes) the greateſt maſter of logick, that ever lived, diſclaimed the courſe taken by other petty philoſophers, (ancient and modern) who not attending the coherence and conſequences of their opinions, are more ſollicitous to make each particular opinion plauſible independently upon the reſt, than to frame them all ſo, as not only to be conſiſtent together, but to ſupport each other. For that great man, in his vaſt and comprehenſive intellect, ſo framed each of his notions, that being curiouſly adapted into one ſyſtem, they need not each of them any other defence than that, which their mutual coherence gives them; as it is in an arch, where each ſingle ſtone, which, if ſever'd from the reſt, would be perhaps defenceleſs, is ſufficiently ſecured by the ſolidity and entireneſs of the whole fabrick, of which it is a part. How juſtly this may be applied to the preſent caſe, I could eaſily ſhew you, if I were permitted to declare to you, how harmonious *Ariſtotle*'s doctrine of the elements is with his other principles of philoſophy; and how rationally he has deduced their number from that of the combinations of the four firſt qualities from the kinds of ſimple motion belonging to ſimple bodies, and from I know not how many other principles and phænomena of nature, which ſo conſpire with his doctrine of the elements, that they mutually ſtrengthen and ſupport each other. But ſince it is forbidden me to inſiſt on reflections of this kind, I muſt proceed to tell you, that though the aſſertors of the four elements, value reaſon ſo highly, and are furniſhed with arguments enough drawn from thence, to be ſatisfied, that there muſt be four elements, though no man had ever yet made any ſenſible trial to diſcover their number, yet they are not deſtitute of experience to ſatisfy others, that are wont to be more ſwayed by their ſenſes, than their reaſon. And I ſhall proceed to conſider the teſtimony of experience, when I ſhall have firſt advertiſed you, that if men were as perfectly rational, as it is to be wiſhed they were, this ſenſible way of probation would be as needleſs, as it is wont to be imperfect. For it is much more high and philoſophical to diſcover things *à priori*, than *à poſteriori*. And therefore the Peripateticks have not been very ſollicitous to gather experiments to prove their doctrines, contenting themſelves with a few only, to ſatisfy thoſe, that are not capable of a nobler conviction. And indeed they employ experiments rather to illuſtrate than to demonſtrate their doctrines, as aſtronomers uſe ſpheres of paſtboard, to deſcend to the capacities of ſuch, as muſt be taught by their ſenſes, for want of being arrived to a clear apprehenſion of purely mathematical notions and truths. I ſpeak thus *Eleutherius* (adds *Themiſtius*) only to do right to reaſon, and not out of diffidence of the experimental proof I am to alledge. For though I ſhall name but one, yet it is ſuch a one, as will make all other appear as needleſs, as it ſelf will be found ſatisfactory. For if you but conſider a piece of green wood burning in a chimney, you will readily diſcern in the diſbanded parts of it the four elements, of which we teach it and other mixt bodies to be compoſed. The fire diſcovers it ſelf in the flame by its own light; the ſmoke, by aſcending to the top of the chimney, and there readily vaniſhing into air, like a river loſing it ſelf in the ſea, ſufficiently manifeſts to what element it belongs, and gladly returns. The water in its own form, boiling and hiſſing at the ends of the burning wood, betrays itſelf to more than one of our ſenſes; and the aſhes by their weight, their fierineſs, and their dryneſs, put it paſt doubt, that they belong to the element of earth. If I ſpoke (continues *Themiſtius*) to leſs knowing perſons, I would perhaps make ſome excuſe for building upon ſuch an obvious and eaſy analyſis; but it would be, I fear, injurious, not to think ſuch an apology needleſs to you, who are too judicious either to think it neceſſary, that experiments to prove obvious truths ſhould be far fetched, or to wonder, that among ſo many mixt bodies, that are compounded of the four elements, ſome of them ſhould, upon a ſlight analyſis, manifeſtly exhibit the ingredients they conſiſt of. Eſpecially ſince it is very agreeable to the goodneſs of nature, to diſcloſe, even in ſome of the moſt obvious experiments, that men make, a truth ſo important and ſo requiſite to be taken notice of by them. Beſides, that our analyſis, by how much the more obvious we make it, by ſo much the more ſuitable it will be to the nature of that doctrine, which it is alledged to prove; which being as clear and intelligible to the underſtanding as obvious to the ſenſe, it is no marvel the learned part of mankind ſhould ſo long and ſo generally imbrace it. For this doctrine is very different from the whimſies of chymiſts and other modern innovators; of whoſe hypotheſes we may obſerve, as naturaliſts do of leſs perfect animals, that as they are haſtily formed, ſo they are commonly ſhort lived. For ſo theſe, as they are often framed in one week, are, perhaps, thought fit to be laughed at the next; and being built, perchance, but upon two or three experiments,

are deſtroyed by a third or fourth, whereas the doctrine of the four elements was framed by *Ariſtotle*, after he had leiſurely conſidered thoſe theories of former philoſophers, which are now with great applauſe revived, as diſcovered by theſe latter ages; and had ſo judiciouſly detected and ſupplied the errors and defect of former hypotheſes concerning the elements, that his doctrine of them has been ever ſince deſervedly embraced by the lettered part of mankind: all the philoſophers, that preceded him, having, in their ſeveral ages, contributed to the completeneſs of this doctrine, as thoſe of ſucceeding times have acquieſced in it. Nor has an hypotheſis, ſo deliberately and maturely eſtabliſhed, been called in queſtion, till in the laſt century *Paracelſus* and ſome few other ſooty empiricks, rather than (as they are fain to call themſelves) philoſophers, having their eyes darkened, and their brains troubled with the ſmoke of their own furnaces, began to rail at the Peripatetick doctrine, which they were too illiterate to underſtand, and to tell the credulous world, that they could ſee but three ingredients in mixed bodies; which, to gain themſelves the repute of inventors, they endeavoured to diſguiſe, by calling them, inſtead of earth, and fire, and vapour, ſalt, ſulphur, and mercury; to which they gave the canting title of hypoſtatical principles. But when they came to deſcribe them, they ſhewed how little they underſtood what they meant by them, by diſagreeing as much from one another, as from the truth they agreed in oppoſing: for they deliver their hypotheſes as darkly as their proceſſes; and it is almoſt as impoſſible for any ſober man to find their meaning, as it is for them to find their elixir. And, indeed, nothing has ſpread their philoſophy, but their great brags and undertakings; notwithſtanding all which, (ſays *Themiſtius* ſmiling) I ſcarce know any thing they have performed worth wondering at, ſave that they have been able to draw *Philoponus* to their party, and to engage him to the defence of an unintelligible hypotheſis, who knows ſo well as he does, that principles ought to be like diamonds, as well very clear, as perfectly ſolid.

THEMISTIUS having after theſe laſt words declared by his ſilence, that he had finiſhed his diſcourſe, *Carneades* addreſſing himſelf, as his adverſary had done, to *Eleutherius*, returned this anſwer to it: I hoped for a demonſtration, but I perceive *Themiſtius* hopes to put me off with an harangue, wherein he cannot have given me a greater opinion of his parts, than he has given me diſtruſt for his hypotheſis, ſince for it even a man of ſuch learning can bring no better arguments. The rhetorical part of his diſcourſe, though it make not the leaſt part of it, I ſhall ſay nothing to, deſigning to examine only the argumentative part, and leaving it to *Philoponus* to anſwer thoſe paſſages, wherein either *Paracelſus* or chymiſts are concerned. I ſhall obſerve to you, that in what he has ſaid beſides, he makes it his buſineſs to do theſe two things. The one to propoſe and make out an experiment to demonſtrate the common opinion about the four elements; and the other, to inſinuate divers things, which he thinks may repair the weakneſs of his argument, from experience, and upon other accounts bring ſome credit to the otherwiſe defenceleſs doctrine he maintains.

TO begin then with his experiment of the burning wood, it ſeems to me to be obnoxious to not a few conſiderable exceptions.

AND firſt, if I would now deal rigidly with my adverſary, I might here make a great queſtion of the very way of probation, which he and others employ, without the leaſt ſcruple, to evince, that the bodies commonly called mixt are made up of earth, air, water, and fire, which they are pleaſed alſo to call elements; namely, that upon the ſuppoſed analyſis made by the fire of the former ſort of concretes, there are wont to emerge bodies reſembling thoſe, which they take for the elements. For, not to anticipate here, what I foreſee I ſhall have occaſion to inſiſt on, when I come to diſcourſe with *Philoponus* concerning the right, that fire has to paſs for the proper and univerſal inſtrument of analyzing mixed bodies; not to anticipate that, I ſay, if I were diſpoſed to wrangle, I might alledge, that by *Themiſtius* his experiment it would appear rather, that thoſe he calls elements, are made of thoſe he calls mixed bodies, than mixed bodies of the elements. For, in *Themiſtius*'s analyzed wood, and in other bodies diſſipated and altered by the fire, it appears, and he confeſſes, that, which he takes for elementary fire and water, are made out of the concrete; but it appears not, that the concrete was made up of fire and water. Nor has either he, or any man, for aught I know, of his perſuaſion, yet proved, that nothing can be obtained from a body by the fire, that was not pre-exiſtent in it.

AT this unexpected objection, not only *Themiſtius*, but the reſt of the company appeared not a little ſurprized; but after a while, *Philoponus* conceiving his opinion, as well as that of *Ariſtotle*, concerned in that objection: You cannot ſure (ſays he, to *Carneades*) propoſe this difficulty, not to call it cavil, otherwiſe than as an exerciſe of wit, and not as laying any weight upon it. For how can that be ſeparated from a thing, that was not exiſtent in it? When, for inſtance, a refiner mingles gold and lead, and expoſing this mixture upon a cupel to the violence of the fire, thereby ſeparates it into pure and refulgent gold and lead (which driven off together with the droſs of the gold, is thence called *lithargyrum auri*) can any man doubt, that ſees theſe two ſo differing ſubſtances ſeparated from the maſs, that they were exiſtent in it, before it was committed to the fire?

I SHOULD (replies *Carneades*) allow your argument to prove ſomething, if, as men ſee, the refiners commonly take beforehand both lead and gold to make the maſs you ſpeak of, ſo we did ſee nature pull down a parcel of the element of fire, that is fancied to be placed I know not how many thouſand leagues off, contiguous to the orb of the moon, and to blend it with a quantity of each of the three elements, to compoſe every mixed body, upon whoſe reſolution

ſolution the fire preſents us with fire, and earth, and the reſt. And let me add, *Philoponus*, that to make your reaſoning cogent, it muſt be firſt proved, that the fire does only take the elementary ingredients aſunder, without otherwiſe altering them. For elſe it is obvious, that bodies may afford ſubſtances, which were not pre-exiſtent in them; as fleſh too long kept produces maggots; and old cheeſe, mites; which I ſuppoſe you will not affirm to be ingredients of thoſe bodies. Now that fire does not always barely ſeparate the elementary parts, but, ſometimes at leaſt, alter alſo the ingredients of bodies, if I did not expect ere long a better occaſion to prove it, I might make probable out of your very inſtance, wherein there is nothing elementary ſeparated by the great violence of the refiner's fire: the gold and lead, which are the two ingredients ſeparated upon the analyſis being confeſſedly yet perfectly mixed bodies, and the litharge being lead indeed, but ſuch lead, as is differing in conſiſtence and other qualities from what it was before. To which I muſt add, that I have ſometimes ſeen, and ſo queſtionleſs have you, much oftener, ſome parcels of glaſs adhering to the teſt or cupel, and this glaſs, though emergent, as well as the gold or litharge, upon your analyſis, you will not, I hope, allow to have been a third ingredient of the maſs, out of which the fire produced it.

BOTH *Philoponus* and *Themiſtius* were about to reply, when *Eleutherius* apprehending, that the proſecution of this diſpute would take up time, which might be better employed, thought fit to prevent them, by ſaying to *Carneades*, You made at leaſt half a promiſe, when you firſt propoſed this objection, that you would not (now at leaſt) inſiſt on it; nor indeed does it ſeem to be of abſolute neceſſity to your cauſe, that you ſhould. For though you ſhould grant, that there are elements, it would not follow, that there muſt be preciſely four; and therefore I hope you will proceed to acquaint us with your other and more conſiderable objections againſt *Themiſtius*'s opinion, eſpecially ſince there is ſo great a diſproportion in bulk betwixt the earth, water and air, on the one part, and thoſe little parcels of reſembling ſubſtances, that the fire ſeparates from concretes, on the other part, that I can ſcarce think, that you are ſerious, when to loſe no advantage againſt your adverſary, you ſeem to deny it to be rational, to conclude theſe great ſimple bodies to be the elements, and not the products of compounded ones.

WHAT you alledge (replies *Carneades*) of the vaſtneſs of the earth and water, has long ſince made me willing to allow them to be the greateſt and chief maſſes of matter to be met with here below: but I think I could ſhew you, if you would give me leave, that this will prove only, that the elements, as you call them, are the chief bodies, that make up the neighbouring part of the world, but not that they are ſuch ingredients as every mixt body muſt conſiſt of. But ſince you challenge me of ſomething of a promiſe, though it be not an entire one, yet I ſhall willingly perform it. And indeed I intended not, when I firſt mentioned this objection, to inſiſt on it at preſent againſt *Themiſtius*, (as I plainly intimated in my way of propoſing it) being only deſirous to let you ſee, that though I diſcerned my advantages, yet I was willing to forego ſome of them, rather than appear a rigid adverſary of a cauſe ſo weak, that it may with ſafety be favourably dealt with. But I muſt here profeſs, and deſire you to take notice of it, that though I paſs on to another argument, it is not becauſe I think this firſt invalid. For you will find, in the progreſs of our diſpute, that I had ſome reaſon to queſtion the very way of probation imployed both by Peripateticks and Chymiſts, to evince the being and number of the elements. For that there are ſuch, and that they are wont to be ſeparated by the analyſis made by fire, is indeed taken for granted by both parties, but has not (for aught I know) been ſo much as plauſibly attempted to be proved by either. Hoping then, that when we come to that part of our debate, wherein conſiderations relating to this matter are to be treated of, you will remember what I have now ſaid, and that I do rather for a while ſuppoſe, than abſolutely grant the truth of what I have queſtioned, I will proceed to another objection.

AND hereupon *Eleutherius* having promiſed him not to be unmindful, when time ſhould ſerve, of what he had declared;

I CONSIDER then (ſays *Carneades*) in the next place, that there are divers bodies, out of which *Themiſtius* will not prove in haſte, that there can be ſo many elements as four extracted by the fire. And I ſhould, perchance, trouble him, if I ſhould aſk him, what Peripatetick can ſhew us, (I ſay not, all the four elements, for that would be too rigid a queſtion, but) any one of them extracted out of gold by any degree of fire whatſoever. Nor is gold the only body in nature, that would puzzle an Ariſtotelian, (that is no more) to analyze by the fire into elementary bodies; ſince, for aught I have yet obſerved, both ſilver and calcined Venetian talc, and ſome other concretes, not neceſſary here to be named, are ſo fixt, that to reduce any of them into four heterogeneous ſubſtances has hitherto proved a taſk much too hard, not only for the diſciples of *Ariſtotle*, but thoſe of *Vulcan*, at leaſt, whilſt the latter have employed only fire to make the analyſis.

THE next argument (continues *Carneades*) that I ſhall urge againſt *Themiſtius*'s opinion ſhall be this; that as there are divers bodies, whoſe analyſis by fire cannot reduce them into ſo many heterogenous ſubſtances or ingredients as four, ſo there are others, which may be reduced into more, as the blood (and divers other parts) of men and other animals; which yield when analyzed five diſtinct ſubſtances, phlegm, ſpirit, oil, ſalt and earth, as experience has ſhewn us in diſtilling man's blood, hartſhorn, and divers other bodies, that, belonging to the animal-kingdom, abound with a not uneaſily ſequeſtrable ſalt.

THE

THE SCEPTICAL CHYMIST:

PART I.

I AM (ſays *Carneades*) ſo unwilling to deny *Eleutherius* any thing, that though, before the reſt of the company, I am reſolved to make good the part I have undertaken of a ſceptick; yet I ſhall readily, ſince you will have it ſo, lay aſide for a while the perſon of an adverſary to the Peripateticks and Chymiſts; and before I acquaint you with my objections againſt their opinions, acknowledge to you, what may be (whether truly or not) tolerably enough added, in favour of a certain number of principles of mixt bodies, to that grand and known argument from the analyſis of compound bodies, which I may poſſibly hereafter be able to confute.

AND that you may the more eaſily examine, and the better judge of what I have to ſay, I ſhall caſt it into a pretty number of diſtinct propoſitions, to which I ſhall not premiſe any thing; becauſe I take it for granted, that you need not be advertiſed, that much of what I am to deliver, whether for or againſt a determinate number of ingredients of mixt bodies, may be indifferently applied to the four Peripatetick elements, and the three chymical principles, though divers of my objections will more peculiarly belong to theſe laſt named; becauſe the chymical hypotheſis ſeeming to be much more countenanced by experience than the other, it will be expedient to inſiſt chiefly upon the diſproving of that; eſpecially ſince moſt of the arguments, that are imployed againſt it, may, by a little variation, be made to conclude, at leaſt as ſtrongly againſt the leſs plauſible Ariſtotelian doctrine.

To proceed then to my propoſitions, I ſhall begins with this, that

Prop. I. *It ſeems not abſurd to conceive, that at the firſt production of mixt bodies, the univerſal matter, whereof they among other parts of the univerſe conſiſted, was actually divided into little particles, of ſeveral ſizes and ſhapes, variouſly moved.*

THIS (ſays *Carneades*) I ſuppoſe you will eaſily enough allow. For beſides that, which happens in the generation, corruption, nutrition, and waſting of bodies, that, which we diſcover partly by our microſcopes of the extream littleneſs of even the ſcarce ſenſible parts of concretes, and partly by the chymical reſolutions of mixt bodies, and by divers other operations of ſpagyrical fires upon them, ſeems ſufficiently to manifeſt their conſiſting of parts very minute, and of differing figures. And that there does alſo intervene a various local motion of ſuch ſmall bodies, will ſcarce be denied; whether we chuſe to grant the origin of concretions aſſigned by *Epicurus*, or that related by *Moſes*. For the firſt, as you well know, ſuppoſes not only all mixt bodies, but all others to be produced by the various and caſual occurſions of atoms, moving themſelves to and fro by an internal principle in the immenſe or rather infinite vacuum. And as for the inſpired hiſtorian, he, informing us, that the great and wiſe author of things did not immediately create plants, beaſts, birds, *&c.* but produced them out of thoſe portions of the pre-exiſtent, though created, matter, that he calls water and earth, allows us to conceive, that the conſtituent particles, whereof theſe new concretes were to conſiſt, were variouſly moved, in order to their being connected into the bodies they were, by their various coalitions and textures, to compoſe.

BUT (continues *Carneades*) preſuming, that the firſt propoſition needs not be longer inſiſted on, I will paſs on to the ſecond, and tell you that

Prop. II. *Neither is it poſſible that of theſe minute particles divers of the ſmalleſt and neighbouring ones were here and there aſſociated into minute maſſes or cluſters, and did by their coalitions conſtitute great ſtore of ſuch little primary concretions or maſſes, as were not eaſily diſſipable into ſuch particles, as compoſed them.*

To what may be deduced, in favour of this aſſertion from the nature of the thing it ſelf, I will add ſomething out of experience; which, though I have not known it uſed to ſuch a purpoſe, ſeems to me more fairly to make out, that there may be elementary bodies, that the more queſtionable experiments of Peripreticks and Chymiſts prove, that there are ſuch. I conſider then, that gold will mix and be colliquated not only with ſilver, copper, tin and lead, but with antimony, *Regulus Martis*, and many other minerals, with which it will compoſe bodies very differing both from gold, and the other ingredients of the reſulting concretes. And the ſame gold will alſo by common aqua regis, and (I ſpeak it knowingly) by divers other menſtruums be reduced into a ſeeming liquor, inſomuch, that the corpuſcles of gold will, with thoſe of the menſtruum, paſs through cap-paper, and with them alſo coagulate into a cryſtalline ſalt. And I have further tried, that with a ſmall quantity of a certain ſaline ſubſtance I prepared, I can eaſily enough ſublime gold into the form of red cryſtals of a conſiderable length; and many other ways may gold be diſguiſed, and help to conſtitute bodies of very differing natures both from it and from one another, and nevertheleſs be afterward reduced to the ſelf-ſame numerical, yellow,

yellow, fixt, ponderous and malleable gold it was before its commixture. Nor is it only the fixedeſt of metals, but the moſt fugitive, that I may employ in favour of our propoſition: for quickſilver will, with divers metals, compoſe an amalgam; with divers menſtruums, it ſeems to be turned into a liquor; with aqua fortis, it will be brought into either a red or white powder, or precipitate; with oil of vitriol, into a pale yellow one; with ſulphur, it will compoſe a blood-red and volatile cinabar; with ſome ſaline bodies, it will aſcend in form of a ſalt, which will be diſſoluble in water; with regulus of antimony and ſilver, I have ſeen it ſublimed into a kind of cryſtals; with another mixture, I reduced it into a malleable body, into a hard and brittle ſubſtance by another: and ſome there are, who affirm, that by proper additaments they can reduce quickſilver into oil, nay into glaſs, to mention no more. And yet out of all theſe exotick compounds, we may recover the very ſame running mercury, that was the main ingredient of them, and was ſo diſguiſed in them. Now the reaſon (proceeds *Carneades*) that I have repreſented theſe things concerning gold and quickſilver, is, that it may not appear abſurd to conceive, that ſuch little primary maſſes or cluſters, as our propoſition mentions, may remain undiſſipated, notwithſtanding their entering into the compoſition of various concretions, ſince the corpuſcles of gold and mercury, though they be not primary concretions of the moſt minute particles of matter, but confeſſedly mixed bodies, are able to concur plentifully to the compoſition of ſeveral very differing bodies, without loſing their own nature or texture, or having their coheſion violated by the divorce of their aſſociated parts or ingredients.

GIVE me leave to add, (ſays *Eleutherius*) on this occaſion, to what you now obſerved, that as confidently as ſome chymiſts, and other modern innovators in philoſophy are wont to object againſt the Peripateticks, that from the mixture of their four elements there could ariſe but an inconſiderable variety of compound bodies; yet, if the Ariſtotelians were but half as well verſed in the works of nature, as they are in the writings of their maſter, the propoſed objection would not ſo calmly triumph, as for want of experiments they are fain to ſuffer it to do. For if we aſſign to the corpuſcles, whereof each element conſiſts, a peculiar ſize and ſhape, it may eaſily enough be manifeſted, that ſuch differingly-figured corpuſcles may be mingled in ſuch various proportions, and may be connected ſo many ſeveral ways, that an almoſt incredible number of variouſly qualified concretes may be compoſed of them. Eſpecially ſince the corpuſcles of one element may barely, by being aſſociated among themſelves, make up little maſſes of differing ſize and figure from their conſtituent parts: and ſince alſo, to the ſtrict union of ſuch minute bodies there ſeems oftentimes nothing requiſite, beſides the bare contact of a great part of their ſurfaces. And how great a variety of phænomena the ſame matter, without the addition of any other, and only ſeveral ways diſpoſed or contexed, is able to exhibit, may partly appear by the multitude of differing engines, which by the contrivances of ſkilful mechanicians, and the dexterity of expert workmen, may be made of iron alone. But, in our preſent caſe, being allowed to deduce compound bodies from four very differently qualified ſorts of matter, he, who ſhall but conſider, what you freſhly took notice of, concerning the new concretes reſulting from the mixture of incorporated minerals, will ſcarce doubt, but that the four elements, managed by nature's ſkill, may afford a multitude of differing compounds.

I AM thus far of your mind (ſays *Carneades*) that the Ariſtotelians might with probability deduce a much greater number of compound bodies from the mixture of their four elements, than according to their preſent hypotheſis they can, if inſtead of vainly attempting to deduce the variety and proprieties of all mixed bodies from the combinations and temperaments of the four elements, as they are (among them) endowed with the four firſt qualities, they had endeavoured to do it by the bulk and figure of the ſmalleſt parts of thoſe ſuppoſed elements. For from theſe more catholick and fruitful accidents of the elementary matter may ſpring a great variety of textures, upon whoſe account a multitude of compound bodies may very much differ from one another. And what I now obſerve touching the four Peripatetick elements, may be alſo applied, *mutatis mutandis*, (as they ſpeak) to the chymical principles. But (to take notice of that by the by) both the one and the other muſt, I fear, call in to their aſſiſtance ſomething, that is not elementary, to excite or regulate the motion of the parts of the matter, and diſpoſe them after the manner requiſite to the conſtitution of particular concretes. For that otherwiſe they are like to give us but a very imperfect account of the origin of very many mixed bodies, it would, I think, be no hard matter to perſuade you, if it would not ſpend time, and were no digreſſion, to examine, what they are wont to alledge of the origin of the textures and qualities of mixed bodies, from a certain ſubſtantial form, whoſe origination they leave more obſcure than what it is aſſumed to explicate.

BUT to proceed to a new propoſition.

Prop. III. *I ſhall not peremptorily deny, that from moſt of ſuch mixed bodies, as partake either of animal or vegetable nature, there may, by the help of the fire, be actually obtained a determinate number (whether three, four, or five, or fewer or more) of ſubſtances, worthy of differing denominations.*

OF the experiments, that induce me to make this conceſſion, I am like to have occaſion enough to mention ſeveral in the proſecution of my diſcourſe. And therefore, that I may not hereafter be obliged to trouble you and my ſelf with needleſs repetitions, I ſhall now only deſire you to take notice of ſuch experiments,

ments, when they ſhall be mentioned, and in your thoughts refer them hither.

To theſe three conceſſions, I have but this fourth to add, that

Prop. IV. *It may likewiſe be granted, that thoſe diſtinct ſubſtances, which concretes generally either afford, or are made up of, may, without very much inconvenience, be called the elements or principles of them.*

WHEN I ſaid, without very much inconvenience, I had in my thoughts that ſober admonition of *Galen*, *cum de re conſtat, de verbis non eſt litigandum*. And therefore alſo I ſcruple not to ſay, elements or principles, partly becauſe the chymiſts are wont to call the ingredients of mixed bodies, principles, as the Ariſtotelians name them, elements; I would here exclude neither: and, partly becauſe it ſeems doubtful, whether the ſame ingredients may not be called principles; as not being compounded of any more primary bodies; and elements, in regard that all mixed bodies are compounded of them. But I thought it requiſite to limit my conceſſion, by premiſing the words, *very much*, to the word *inconvenience*; becauſe, that though the inconvenience of calling the diſtinct ſubſtances, mentioned in the propoſition, elements or principles, be not very great, yet that it is impropriety of ſpeech, and conſequently in a matter of this moment not to be altogether overlooked, you will perhaps think, as well as I, by that time you ſhall have heard the following part of my diſcourſe, by which you will beſt diſcern what conſtruction to put upon the former propoſitions, and how far they may be looked upon, as things that I concede as true, and how far as things I only repreſent as ſpecious enough to be fit to be conſidered.

AND now *Eleutherius* (continues *Carneades*) I muſt reſume the perſon of a ſceptick, and, as ſuch, propoſe ſome part of what may be either diſliked, or at leaſt doubted of, in the common hypotheſis of the chymiſts; which if I examine with a little the more freedom, I hope I need not deſire you (a perſon to whom I have the happineſs of being ſo well known) to look upon it as ſomething more ſuitable to the employment, whereto the company has, for this meeting, doomed me, than either to my humour or my cuſtom.

Now though I might preſent you many things againſt the vulgar chymical opinion of the three principles, and the experiments wont to be alledged as demonſtrations of it; yet thoſe I ſhall at preſent offer you, may be conveniently enough comprehended in four capital conſiderations: touching all which I ſhall only premiſe this in general, that ſince it is not my preſent taſk ſo much to aſſert an hypotheſis of my own, as to give an account wherefore I ſuſpect the truth of that of the chymiſts, it ought not to be expected, that all my objections ſhould be of the moſt cogent ſort, ſince it is reaſon enough to doubt of a propoſed opinion, that there appears no cogent reaſon for it.

To come then to the objections themſelves; I conſider in the firſt place, that notwithſtanding what common chymiſts have proved or taught, it may reaſonably enough be doubted, how far, and in what ſenſe, fire ought to be eſteemed the genuine and univerſal inſtrument of analyzing mixed bodies.

THIS doubt, you may remember, was formerly mentioned, but ſo tranſiently diſcourſed of, that it will now be fit to inſiſt upon it; and manifeſt, that it was not ſo inconſiderately propoſed as our adverſaries then imagined.

BUT, before I enter any further into this diſquiſition, I cannot but here take notice, that it were to be wiſhed, our chymiſts had clearly informed us, what kind of diviſion of bodies by fire muſt determine the number of the elements: for it is nothing near ſo eaſy, as many ſeem to think, to determine diſtinctly the effects of heat, as I could eaſily manifeſt, if I had leiſure to ſhew you, how much the operations of fire may be diverſified by circumſtances. But not wholly to paſs by a matter of this importance, I will firſt take notice to you, that guaiacum (for inſtance) burnt with an open fire in a chimney, is ſequeſtered into aſhes and ſoot, whereas the ſame wood diſtilled in a retort does yield far other heterogeneities, (to uſe the Helmontian expreſſion) and is reſolved into oil, ſpirit, vinegar, water and charcoal; the laſt of which, to be reduced into aſhes, requires the being farther calcined than it can be in a cloſe veſſel. Beſides, having kindled amber, and held a clean ſilver ſpoon, or ſome other concave and ſmooth veſſel, over the ſmoke of its flame, I obſerved the ſoot, into which that fume condenſed, to be very differing from any thing, that I had obſerved to proceed from the ſteam of amber purpoſely (for that is not uſual) diſtilled *per ſe* in cloſe veſſels. Thus having, for trial's ſake, kindled camphire, and catched the ſmoke, that copiouſly aſcended out of the flame, it condenſed into a black and unctuous ſoot, which would not have been gueſſed by the ſmell or other properties to have proceeded from camphire: whereas having (as I ſhall otherwhere more fully declare) expoſed a quantity of that fugitive concrete to a gentle heat in a cloſe glaſs-veſſel, it, ſublimed up without ſeeming to have loſt any thing of its whiteneſs, or its nature; both which it retained, though afterwards I ſo increaſed the fire, as to bring it to fuſion. And, beſides camphire, there are divers other bodies (that I elſewhere name) in which the heat in cloſe veſſels is not wont to make any ſeparation of heterogeneities, but only a comminution of parts, thoſe that riſe firſt being homogeneal with the others, though ſubdivided into ſmaller particles: whence ſublimations have been ſtyled, *The Peſtles of the Chymiſts*. But not here to mention what I elſewhere take notice of, concerning common brimſtone once or twice ſublimed, that, expoſed to a moderate fire in ſubliming-pots, it riſes all into dry, and almoſt taſteleſs, flowers; whereas being expoſed to a naked fire, it affords ſtore of a ſaline and fretting liquor: not to mention this, I ſay, I will further obſerve to you, that as it is conſiderable in the analyſis of mixt bodies, whether the fire act on them, when they are expoſed to the open air,

air, or ſhut up in cloſe veſſels, ſo is the degree of fire, by which the analyſis is attempted, of no ſmall moment. For a mild balneum will ſever unfermented blood (for inſtance) but into phlegm and *caput mortuum*, the latter whereof (which I have ſometimes had) hard, bittle, and of divers colours, (tranſparent almoſt like toitoiſe-ſhell) preſſed by a good fire in a retort yields a ſpirit, an oil or two, and a volatile ſalt, beſides another *caput mortuum*. It may be alſo pertinent to our preſent deſign, to take notice of what happens in the making and diſtilling of ſoap; for by one degree of fire, the ſalt, the water, and the oil or greaſe, whereof that factitious concrete is made up, being boiled up together, are eaſily brought to mingle and incorporate into one maſs; but by another and further degree of heat, the ſame maſs may be again divided into an oleaginous and aqueous, a ſaline and an earthy part. And ſo we may obſerve, that impure ſilver and lead being expoſed together to a moderate fire, will thereby be colliquated into one maſs, and mingle *per minima*, as they ſpeak; whereas a much vehementer fire will drive or carry off the baſer metals (I mean the lead, and the copper or other alloy) from the ſilver, though not, for aught appears, ſeparate them from one another. Beſides, when a vegetable abounding in fixed ſalt is analyzed by a naked fire, as one degree of heat will reduce it into aſhes, (as the chymiſts themſelves teach us) ſo, by only a further degree of fire, thoſe aſhes may be vitrified and turned into glaſs. I will not ſtay to examine, how far a mere chymiſt might on this occaſion demand, if it be lawful for an Ariſtotelian to make aſhes (which he miſtakes for mere earth) paſs for an element, becauſe by one degree of fire it may be produced, why a chymiſt may not upon the like principle argue, that glaſs is one of the elements of many bodies, becauſe that alſo may be obtained from them, barely by the fire? I will not, I ſay, loſe time to examine this, but obſerve, that by a method of applying the fire, ſuch ſimilar bodies may be obtained from a concrete, as chymiſts have not been able to ſeparate; either by barely burning it in an open fire, or by barely diſtilling it in cloſe veſſels. For to me it ſeems very conſiderable, and I wonder, that men have taken ſo little notice of it, that I have not, by any of the common ways of diſtillation in cloſe veſſels, ſeen any ſeparation made of ſuch a volatile ſalt as is afforded us by wood, when that is firſt by an open fire divided into aſhes and ſoot, and that ſoot is afterwards placed in a ſtrong retort, and compelled by an urgent fire to part with its ſpirit, oil and ſalt. For though I dare not peremptorily deny, that in the liquors of guaiacum and other woods diſtilled in retorts after the common manner, there may be ſaline parts, which by reaſon of the analogy may pretend to the name of ſome kind of volatile ſalts; yet queſtionleſs there is a great diſparity betwixt ſuch ſalts, and that which we have ſometimes obtained upon the firſt diſtillation of ſoot, (though for the moſt part it has not been ſeparated from the firſt or ſecond rectification, and ſometimes not till the third). For we could never yet ſee ſeparated from woods analyzed only the vulgar way in cloſe veſſels any volatile ſalt in a dry and ſaline form, as that of ſoot, which we have often had very cryſtalline, and geometrically figured. And then, whereas the ſaline parts of the ſpirits of guaiacum, *&c.* appear upon diſtillation ſluggiſh enough, the ſalt of ſoot ſeems to be one of the moſt volatile bodies in all nature; and if it be well made, will readily aſcend with the mild heat of a furnace, warmed only by the ſingle wiek of a lamp, to the top of the higheſt glaſs veſſels that are commonly made uſe of for diſtillation. And beſides all this, the taſte and ſmell of the ſalt of ſoot are exceeding differing from thoſe of the ſpirits of guaiacum, *&c.* and the former not only ſmells and taſtes much leſs like a vegetable ſalt, than like that of hartſhorn, and other animal concretes; but in divers other properties ſeems more of kin to the family of animals, than to that of vegetable ſalts, as I may elſewhere (God permitting) have an occaſion more particularly to declare. I might likewiſe by ſome other examples manifeſt, that the chymiſts, to have dealt clearly, ought to have more explicitly and particularly declared by what degree of fire, and in what manner of application of it, they would have us judge a diviſion made by the fire to be a true analyſis into their principles, and the productions of it to deſerve the name of elementary bodies. But it is time, that I proceed to mention the particular reaſons, that incline me to doubt, whether the fire be the true and univerſal analyzer of mixt bodies; of which reaſons, what has been already objected may paſs for one.

IN the next place, I obſerve, that there are ſome mixt bodies, from which it has not been yet made appear, that any degree of fire can ſeparate either ſalt, or ſulphur, or mercury, much leſs all the three. The moſt obvious inſtance of this truth is gold, which is a body ſo fixed, and wherein the elementary ingredients (if it have any) are ſo firmly united to each other, that we find not in the operations, wherein gold is expoſed to the fire, how violent ſoever, that it does diſcernably ſo much as loſe of its fixedneſs or weight, ſo far is it from being diſſipated into thoſe principles, whereof one at leaſt is acknowledged to be fugitive enough; and ſo juſtly did the ſpagyrical poet ſomewhere exclaim,

Cuncta adeo miris illic compagibus hærent.

AND I muſt not omit on this occaſion to mention to you, *Eleutherius*, the memorable experiment, that I remember I met with in *Gaſto Claveus*, who, though a lawyer by profeſſion, ſeems to have had no ſmall curioſity and experience in chymical affairs. He relates then, that having put into one ſmall earthen veſſel, an ounce of the moſt pure gold, and into another the like weight of pure ſilver, he placed them both in that part of a glaſs-houſe furnace, wherein the workmen keep their metal, (as our Engliſh artificers call their liquid glaſs) continually melted; and, that having there kept both the

Gaſto Claveus *Apolog. Argur. & Cryſopera.*

the gold and the ſilver in conſtant fuſion for two months together, he afterwards took them out of the furnace and the veſſels, and weighing both of them again, found, that the ſilver had not loſt above a 12th part of its weight, but the gold had not of his loſt any thing at all. And though our author endeavours to give us of this a ſcholaſtick reaſon, which I ſuppoſe you would be as little ſatisfied with, as I was when I read it; yet for the matter of fact, which will ſerve our preſent turn, he aſſures us, that though it be ſtrange, yet experience it ſelf taught it him to be moſt true.

AND though there be not perhaps any other body to be found ſo perfectly fixed as gold, yet there are divers others ſo fixed or compoſed, at leaſt of ſo ſtrictly united parts, that I have not yet obſerved the fire to ſeparate from them any one of the chymiſts principles. I need not tell you, what complaints the more candid and judicious of the chymiſts themſelves are wont to make of thoſe boaſters, that confidently pretend, that they have extracted the ſalt or ſulphur of quickſilver, when they have diſguiſed it by additaments, wherewith it reſembles the concretes, whoſe names are given it; whereas by a ſkilful and rigid examen, it may be eaſily enough ſtripped of its diſguiſes, and made to appear again in the priſtine form of running mercury. The pretended ſalts and ſulphurs being ſo far from being elementary parts extracted out of the body of mercury, that they are rather (to borrow a term of the grammarians) de-compound bodies, made up of the whole metal and the menſtruum, or other additaments imployed to diſguiſe it. And as for ſilver, I never could ſee any degree of fire make it part with any of its three principles. And though the experiment lately mentioned from *Claveus* may beget a ſuſpicion, that ſilver may be diſſipated by fire, provided it be extremely violent and very laſting; yet it will not neceſſarily follow, that becauſe the fire was able at length to make the ſilver loſe a little of its weight, it was therefore able to diſſipate it into its principles. For firſt I might alledge, that I have obſerved little grains of ſilver to lie hid in the ſmall cavities (perhaps glaſſed over by a vitrifying heat) in crucibles, wherein ſilver has been long kept in fuſion, whence ſome goldſmiths of my acqaaintance make a benefit by grinding ſuch crucibles to powder, to recover out of them the latent particles of ſilver. And hence I might argue, that perhaps *Claveus* was miſtaken, and imagined, that ſilver to have been driven away by the fire, that indeed lay in minute parts hid in his crucible, in whoſe pores ſo ſmall a quantity, as he miſſed of ſo ponderous a body, might very well lie concealed.

BUT ſecondly, admitting, that ſome parts of the ſilver were driven away by the violence of the fire, what proof is there, that it was either the ſalt, the ſulphur, or the mercury of the metal, and not rather a part of it homogeneous to what remained? for beſides that the ſilver, that was left, ſeemed not ſenſibly altered, which probably would have appeared, had ſo much of any one of its principles been ſeparated from it; we find in other mineral bodies of a leſs permanent nature than ſilver, that the fire may divide them into ſuch minute parts, as to be able to carry them away with itſelf, without at all deſtroying their nature. Thus we ſee, that in the refining of ſilver, the lead, that is mixed with it (to carry away the copper or other ignoble mineral that embaſes the ſilver) will, if it be let alone, in time evaporate away upon the teſt; but if (as is moſt uſual amongſt thoſe, that refine great quantities of metals together) the lead be blown off from the ſilver by bellows, that, which would elſe have gone away in the form of unheeded ſteams, will, in great part, be collected not far from the ſilver, in the form of a darkiſh powder or calx; which, becauſe it is blown off from ſilver, they call litharge of ſilver. And thus *Agricola* in divers places informs us, when copper, or the ore of it is colliquated by the violence of the fire with Cadmia, the ſparks, that in great multitudes do fly upwards, do ſome of them ſtick to the vaulted roofs of the furnaces, in the form of little and (for the moſt part) white bubbles; which therefore the Greeks, and, in imitation of them, our drugſters call pompholyx: and others more heavy partly adhere to the ſides of the furnace, and partly (eſpecially if the covers be not kept upon the pots) fall to the ground, and by reaſon of their aſhy colour, as well as weight, were called by the ſame Greeks σποδὸς, which, I need not tell you, in their language ſignifies aſhes. I might add, that I have not found, that from Venetian talc (I ſay Venetian, becauſe I have found other kinds of that mineral more open) from the lapis oſſifragus, (which the ſhops call oſtiocolla) from *Muſcovia* glaſs, from pure and fuſible ſand (to mention now no other concretes) thoſe of my acquaintance, that have tried, have been able by the fire to ſeparate any one of the hypoſtatical principles: which you will the leſs ſcruple to believe, if you conſider, that glaſs may be made by the bare colliquation of the ſalt and earth remaining in the aſhes of a burnt plant, and that yet common glaſs, once made, does ſo far reſiſt the violence of the fire, that moſt chymiſts think it a body more undeſtroyable than gold it ſelf. For if the artificer can ſo firmly unite ſuch comparative groſs particles as thoſe of earth and ſalt, that make up common aſhes, into a body indiſſoluble by fire, why may not nature aſſociate in divers bodies, the more minute elementary corpuſcles, ſhe has at hand, too firmly to let them be ſeparable by the fire? And on this occaſion, *Eleutherius*, give me leave to mention to you two or three ſlight experiments, which will, I hope, be found more pertinent to our preſent diſcourſe, than at firſt perhaps they will appear. The firſt is, that, having (for trial's ſake) put a quantity of that fugitive concrete, camphire, into a glaſs veſſel, and placed it in a gentle heat, I found it (not leaving behind, according to my eſtimate, not ſo much as one grain) to ſublime to the top of the veſſel into flowers; which in whiteneſs, ſmell, *&c.* ſeemed not to differ from the camphire it ſelf. Another experiment is that of *Helmont*, who, in ſeveral places affirms, that a coal kept in a

Agricola *de Natura Foſſil.* Lib. 9. cap. 11, *and* 12.

glaſs

glaſs exactly cloſed will never be calcined to aſhes, though kept never ſo cloſe in a ſtrong fire. To countenance which, I ſhall tell you this trial of my own, that having ſometimes diſtilled ſome woods, as particularly box, whilſt our *caput mortuum* remained in the retort, it continued black like charcoal, though the retort were earthen, and kept red-hot in a vehement fire: but as ſoon as ever it was brought out of the candent veſſel into the open air, the burning coals did haſtily degenerate or fall aſunder, without the aſſiſtance of any new calcination, into pure white aſhes. And to theſe two I ſhall add but this obvious and known obſervation, that common ſulphur (if it be pure and freed from its vinegar) being leiſurely ſublimed in cloſe veſſels, riſes into dry flowers, which may be preſently melted into a body of the ſame nature with that which afforded them. Though, if brimſtone be burnt in the open air, it gives, you know, a penetrating fume, which being caught in a glaſs-bell, condenſes into that acid liquor called oil of ſulphur *per campanam*. The uſe I would make of theſe experiments, collated with what I lately told you out of *Agricola*, is this, that even among the bodies, that are not fixt, there are divers of ſuch a texture, that it will be hard to make it appear, how the fire, as chymiſts are wont to imploy it, can reſolve them into elementary ſubſtances. For ſome bodies being of ſuch a texture, that the fire can drive them into the cooler and leſs hot part of the veſſels, wherein they are included, and, if need be, remove them from place to place, to fly the greateſt heat, more eaſily than it can divorce their elements (eſpecially without the aſſiſtance of the air) we ſee, that our chymiſts cannot analyze them in cloſe veſſels, and of other compound bodies the open fire can as little ſeparate the elements. For what can a naked fire do to analyze a mixt body, if its component principles be ſo minute, and ſo ſtrictly united, that the corpuſcles of it need leſs heat to carry them up, than is requiſite to divide them into their principles? So that of ſome bodies the fire cannot in cloſe veſſels make any analyſis at all; and others will in the open air fly away in the forms of flowers or liquors, before the heat can prove able to divide them into their principles. And this may hold, whether the various ſimilar parts of a concrete be combined by nature or by art; for in factitious ſal armoniac we find the common and the urinous ſalts ſo well mingled, that both in the open fire, and in ſubliming veſſels they riſe together, as one ſalt, which ſeems in ſuch veſſels irreſoluble by fire alone. For I can ſhew you ſal armoniac, which after the ninth ſublimation does ſtill retain its compounded nature. And indeed I ſcarce know any one mineral, from which by fire alone chymiſts are wont to ſever any ſubſtance ſimple enough to deſerve the name of an element or principle. For though out of native cinnabar they diſtil quickſilver, and though from many of thoſe ſtones, that the ancients called *Pyrites*, they ſublime brimſtone, yet both that quickſilver and this ſulphur, being very often the ſame with the common minerals, that are ſold in the ſhops under thoſe names, are themſelves too much compounded bodies to paſs for the elements of ſuch. And thus much, *Eleutherius*, for the ſecond argument, that belongs to my firſt conſideration; the others I ſhall the leſs inſiſt on, becauſe I have dwelt ſo long upon this.

PROCEED we then, in the next place, to conſider, that there are divers ſeparations to be made by other means, which either cannot at all, or elſe cannot ſo well be made by the fire alone. When gold and ſilver are melted into one maſs, it would lay a great obligation upon refiners and goldſmiths, to teach them the art of ſeparating them by the fire, without the trouble and charge they are fain to be at to ſever them. Whereas they may be very eaſily parted by the affuſion of ſpirit of nitre or aqua fortis; which the French therefore call *eau de depart*. So likewiſe the metalline part of vitriol will not be ſo eaſily and conveniently ſeparated from the ſaline part, even by a violent fire, as by the affuſion of certain alkalizate ſalts, in a liquid form, upon the ſolution of vitriol made in common water. For thereby the acid ſalt of the vitriol leaving the copper, it had corroded, to join with the added ſalts, the metalline part will be precipitated to the bottom almoſt like mud. And that I may not give inſtances only in decompound bodies, I will add a not uſeleſs one of another kind. Not only chymiſts have not been able (for aught is vulgarly known) by fire alone to ſeparate true ſulphur from antimony; but though you may find in their books many plauſible proceſſes of extracting it, yet he, that ſhall make as many fruitleſs trials as I have done to obtain it, by moſt of them will, I ſuppoſe, be eaſily perſuaded, that the productions of ſuch proceſſes are antimonial ſulphurs rather in name than nature. But though antimony ſublimed by itſelf is reduced but to a volatile powder, or antimonial flowers, of a compounded nature like the mineral, that affords them; yet I remember, that ſome years ago I ſublimed out of antimony a ſulphur, and that in greater plenty than ever I ſaw obtained from that mineral, by a method, which I ſhall therefore acquaint you with, becauſe chymiſts ſeem not to have taken notice, of what importance ſuch experiments may be in the indagation of the nature, and eſpecially of the number of the elements. Having then purpoſely for trial ſake digeſted eight ounces of good and well powdered antimony with twelve ounces of oil of vitriol, in a well ſtopped glaſs-veſſel, for about ſix or ſeven weeks; and having cauſed the maſs (grown hard and brittle) to be diſtilled in a retort placed in ſand, with a ſtrong fire; we found the antimony to be ſo opened, or altered by the menſtruum, wherewith it had been digeſted, that whereas crude antimony, forced up by the fire, ariſes only in flowers, our antimony thus handled afforded us partly in the receiver, and partly in the neck and at the top of the retort, about an ounce of ſulphur, yellow and brittle like common brimſtone, and of ſo ſulphureous a ſmell, that upon the unluting the veſſels it infected the room with a ſcarce ſupportable ſtink. And this ſulphur, beſides the colour

and ſmell, had the perfect inflammability of common brimſtone, and would immediately kindle (at the flame of a candle) and burn blue like it. And though it ſeemed, that the long digeſtion, wherein our antimony and menſtruum were detained, did conduce to the better unlocking of the mineral, yet if you have not the leiſure to make ſo long a digeſtion, you may, by incorporating with powdered antimony a convenient quantity of oil of vitriol, and committing them immediately to diſtillation, obtain a little ſulphur like unto the common one, and more combuſtible than, perhaps, you will at firſt take notice of. For I have obſerved, that though (after its being firſt kindled) the flame would ſometimes go out too ſoon of itſelf, if the ſame lump of ſulphur were held again to the flame of a candle, it would be rekindled and burn a pretty while, not only after the ſecond, but after the third or fourth accenſion. You, to whom I think I ſhewed my way of diſcovering ſomething of ſulphureous in oil of vitriol, may perchance ſuſpect, *Eleutherius*, either that this ſubſtance was ſome venereal ſulphur, that lay hid in that liquor, and was by this operation only reduced into a manifeſt body; or elſe, that it was a compound of the unctuous parts of the antimony, and the ſaline ones of the vitriol, in regard, that (as *Günther* informs us) divers learned men would have ſulphur to be nothing but a mixture, made in the bowels of the earth, of vitriolate ſpirits and a certain combuſtible ſubſtance: But the quantity of ſulphur we obtained by digeſtion was much too great to have been latent in the oil of vitriol. And that vitriolate ſpirits are not neceſſary to the conſtruction of ſuch a ſulphur as ours, I could eaſily manifeſt, if I would acquaint you with the ſeveral ways, by which I have obtained, though not in ſuch plenty, a ſulphur of antimony, coloured and combuſtible like common brimſtone. And though I am not now minded to diſcover them, yet I ſhall tell you, that to ſatisfy ſome ingenious men, that diſtilled vitriolate ſpirits are not neceſſary to the obtaining of ſuch a ſulphur as we have been conſidering, I did by the bare diſtillation of only ſpirit of nitre, from its weight of crude antimony, ſeparate, in a ſhort time, a yellow and very inflammable ſulphur; which, for aught I know, deſerves as much the name of an element, as any thing, that chymiſts are wont to ſeparate from any mineral by the fire. I could perhaps tell you of other operations upon antimony, whereby that may be extracted from it, which cannot be forced out of it by the fire; but I ſhall reſerve them for a fitter opportunity, and only annex at preſent this ſlight, but not impertinent experiment: That whereas I lately obſerved to you, that the urinous and common ſalts, whereof ſal armoniac conſiſts, remained unſever'd by the fire in many ſucceſſive ſublimations, they may be eaſily ſeparated, and partly without any fire at all, by pouring upon the concrete finely powdered, a ſolution of ſalt of tartar, or of the ſalt of wood-aſhes: for upon your diligently mixing of theſe, you will find your noſe invaded with a very ſtrong ſmell of urine, and perhaps too your eyes forced to water, by the ſame ſubtile and piercing body, that produces the ſtink; both theſe effects proceeding from hence, that by the alcalizate ſalt, the ſea ſalt, that entered the compoſition of the ſal armoniac, is mortified and made more fixt, and thereby a divorce is made between it and the volatile urinous ſalt; which being at once ſet at liberty, and put into motion, begins preſently to fly away, and to offend the noſtrils and eyes it meets with by the way. And if the operation of theſe ſalts be in convenient glaſſes promoted by warmth, though but by that of a bath, the aſcending ſteams may eaſily be caught and reduced into a penetrant ſpirit, abounding with a ſalt, which I have ſometimes found to be ſeparable in a cryſtalline form. I might add to theſe inſtances, that whereas ſublimate, conſiſting, as you know, of ſalts and quickſilver combined and carried up together by heat, may be ſublimed, I know not how often, by a like degree of fire, without ſuffering any divorce of the component bodies, the mercury may be eaſily ſever'd from the adhering ſalts, if the ſublimate be diſtilled from ſalt of tartar, quick lime, or ſuch alkalizate bodies. But I will rather obſerve to you, *Eleutherius*, what divers ingenious men have thought ſomewhat ſtrange; that by ſuch an additament, that ſeems but only to promote the ſeparation, there may be eaſily obtained from a concrete, that by the fire alone is eaſily diviſible into all the elements, that vegetables are ſuppoſed to conſiſt of, ſuch a ſimilar ſubſtance, as differs in many reſpects from them all, and conſequently has by many of the moſt intelligent chymiſts been denied to be contained in the mixt body. For I know a way, and have practiſed it, whereby common tartar, without the addition of any thing, that is not perfectly a mineral, except ſalt-petre, may by one diſtillation in an earthen retort be made to afford good ſtore of real ſalt readily diſſoluble in water; which I found to be neither acid, nor of the ſmell of tartar, and to be almoſt as volatile as ſpirit of wine it ſelf, and to be indeed of ſo differing a nature from all, that is wont to be ſeparated by fire from tartar; and divers learned men, with whom I diſcourſed of it, could hardly be brought to believe, that ſo fugitive a ſalt could be afforded by tartar, till I aſſured it them upon my own knowledge. And if I did not think you apt to ſuſpect me to be rather too backward than too forward to credit or affirm unlikely things, I could convince you, by what I have yet lying by me, of that anomalous ſalt.

Lib. 1. *Obſervat.* cap. 6.

THE fourth thing, that I ſhall alledge to countenance my firſt conſideration, is, that the fire, even when it divides a body into ſubſtances of divers conſiſtencies, does not moſt commonly analyze it into hypoſtatical principles, but only diſpoſes its parts into new textures, and thereby produces concretes of a new indeed, but yet of a compound nature. This argument it will be requiſite for me to proſecute ſo fully hereafter, that I hope you will then confeſs, that it is not for want of good proofs, that I deſire leave to ſuſpend my proofs, till the ſeries of my diſcourſe

ſhall

ſhall make it more proper and ſeaſonable to propoſe them.

IT may be further alledged on the behalf of my firſt conſideration, that ſome ſuch diſtinct ſubſtances may be obtained from ſome concretes without fire, as deſerve no leſs the name of elementary, than many, that chymiſts extort by the violence of the fire.

WE ſee, that the inflammable ſpirit, or, as the chymiſts eſteem it, the ſulphur of wine, may not only be ſeparated from it by the gentle heat of a bath, but may be diſtilled either by the help of the ſun-beams, or even of a dunghill, being indeed of ſo fugitive a nature, that it is not eaſy to keep it from flying away, even without the application of external heat. I have likewiſe obſerved, that a veſſel full of urine being placed in a dunghill, the putrefaction is wont, after ſome weeks, ſo to open the body, that the parts diſbanding the ſaline ſpirit, will within no very long time, if the veſſel be not ſtopped, fly away of itſelf; inſomuch, that from ſuch urine I have been able to diſtil little or nothing elſe than a nauſeous phlegm, inſtead of the active and piercing ſalt and ſpirit, that it would have afforded, when firſt expoſed to the fire, if the veſſel had been carefully ſtopped.

AND this leads me to conſider, in the fifth place, that it will be very hard to prove, that there can no other body or way be given, which will, as well as the fire, divide concretes into ſeveral homogeneous ſubſtances, which may conſequently be called their elements or principles, as well as thoſe ſeparated or produced by the fire. For ſince we have lately ſeen, that nature can ſucceſsfully employ other inſtruments than the fire to ſeparate diſtinct ſubſtances from mixed bodies, how know we, but that nature has made, or art may make, ſome ſuch ſubſtance, as may be a fit inſtrument to analyze mixt bodies, or that ſome ſuch method may be found by human induſtry or luck, by whoſe means compound bodies may be reſolved into other ſubſtances, than ſuch as they are wont to be divided into by the fire? And why the products of ſuch an analyſis may not as juſtly be called the component principles of the bodies, that afford them, it will not be eaſy to ſhew; eſpecially ſince I ſhall hereafter make it evident, that the ſubſtances, which chymiſts are wont to call the ſalts, and ſulphurs, and mercuries of bodies, are not ſo pure and elementary as they preſume, and as their hypotheſis requires. And this may therefore be the more freely preſſed upon the chymiſts, becauſe neither the Paracelſians, nor the Helmontians, can reject it without apparent injury to their reſpective maſters. For *Helmont* does more than once inform his readers, that both *Paracelſus* and himſelf were poſſeſſors of the famous liquor, alkaheſt, which for its great power in reſolving bodies irreſoluble by vulgar fires, he ſomewhere ſeems to call *Ignis Gehennæ*. To this liquor he aſcribes, (and that in great part upon his own experience) ſuch wonders, that if we ſuppoſe them all true, I am ſo much the more a friend to knowledge than to wealth, that I ſhould think the alkaheſt a nobler and more deſirable ſecret, than the philoſophers ſtone it ſelf. Of this univerſal diſſolvent he relates, that having digeſted with it for a competent time a piece of oaken charcoal, it was thereby reduced into a couple of new and diſtinct liquors, diſcriminated from each other by their colour and ſituation, and that the whole body of the coal was reduced into thoſe liquors, both of them ſeparable from his immortal menſtruum, which remained as fit for ſuch operations as before. And he moreover tells us in divers places of his writings, that by his powerful, and unwearied agent, he could diſſolve metals, marchaſites, ſtones, vegetable and animal bodies of what kind ſoever, and even glaſs itſelf (firſt reduced to powder,) and in a word, all kind of mixt bodies in the world, into their ſeveral ſimilar ſubſtances, without any reſidence or *caput mortuum*. And laſtly, we may gather this further from his informations, that the homogeneous ſubſtances obtainable from compound bodies by his piercing liquor, were oftentimes different enough both as to number and as to nature, from thoſe into which the ſame bodies are wont to be divided by common fire. Of which I ſhall need in this place to mention no other proof, than that whereas we know, that in our common analyſis of a mixt body, there remains a terreſtrial and very fixed ſubſtance, oftentimes aſſociated with a ſalt as fixed; our author tells us, that by his way he could diſtil over all concretes without any *caput mortuum*, and conſequently could make thoſe parts of the concrete volatile, which in the vulgar analyſis would have been fixt. So that if our chymiſts will not reject the ſolemn and repeated teſtimony of a perſon, who cannot but be acknowledged for one of the greateſt ſpagyriſts, that they can boaſt of, they muſt not deny, that there is to be found in nature another agent able to analyze compound bodies leſs violently, and both more genuinely and more univerſally than the fire. And for my own part, though I cannot but ſay on this occaſion what (you know) our friend Mr. *Boyle* is wont to ſay, when he is aſked his opinion of any ſtrange experiment, *That he, that hath ſeen it, hath more reaſon to believe it, than he that hath not*; yet I have found *Helmont* ſo faithful a writer, even in divers of his improbable experiments (I always except that extravagant treatiſe *De Magnetica Vulnerum Curatione*, which ſome of his friends affirm to have been firſt publiſhed by his enemies) that I think it ſomewhat harſh to give him the lye, eſpecially to what he delivers upon his own proper trial. And I have heard from very credible eye-witneſſes ſome things, and ſeen ſome others my ſelf, which argue ſo ſtrongly, that a circulated ſalt, or a menſtruum (ſuch as it may be) may, by being abſtracted from compound bodies, whether mineral, animal, or vegetable, leave them more unlocked than a wary naturaliſt would eaſily believe; that I dare not confidently meaſure the power of nature and art by that of the menſtruums, and other inſtruments that eminent chymiſts themſelves are as yet wont to employ about the analyzing of bodies; nor deny, that a menſtruum

ſtruum may at leaſt from this or that particular concrete obtain ſome apparently ſimilar ſubſtance, differing from any obtainable from the ſame body by any degree or manner of application of the fire. And I am the more backward to deny peremptorily, that there may be ſuch openers of compound bodies, becauſe among the experiments, that make me ſpeak thus warily, there wanted not ſome, in which it appeared not, that one of the ſubſtances, not ſeparable by common fires and menſtruums, could retain any thing of the ſalt, by which the ſeparation was made.

AND here, *Eleutherius*, (ſays *Carneades*) I ſhould conclude as much of my diſcourſe as belongs to the firſt conſideration I propoſed, but that I foreſee, that what I have delivered will appear liable to two ſuch ſpecious objections, that I cannot ſafely proceed any further, till I have examined them.

AND firſt, one ſort of oppoſers will be forward to tell me, that they do not pretend by fire alone to ſeparate out of all compound bodies their hypoſtatical principles; it being ſufficient, that the fire divides them into ſuch, though afterwards they employ other bodies to collect the ſimilar parts of the compound; as it is known, that though they make uſe of water to collect the ſaline parts of aſhes from the terreſtrial, wherewith they are blended, yet it is the fire only, that incinerates bodies, and reduces the fixed part of them into the ſalt and earth, whereof aſhes are made up. This objection is not, I confeſs, inconſiderable, and I might in great part allow of it, without granting it to make againſt me, if I would content my ſelf to anſwer, that it is not againſt thoſe, that make it, that I have been diſputing, but againſt thoſe vulgar chymiſts, who themſelves believe, and would fain make others do ſo, that the fire is not only an univerſal, but an adequate and ſufficient inſtrument to analyze mixt bodies with. For as to their practice of extracting the fixed ſalt out of aſhes by the affuſion of water, it is obvious to alledge, that the water does only aſſemble together the ſalt the fire had before divided from the earth: as a ſieve does not further break the corn, but only bring together into two diſtinct heaps the flower and the bran, whoſe corpuſcles before lay promiſcuouſly blended together in the meal. This I ſay I might alledge, and thereby exempt my ſelf from the need of taking any farther notice of the propoſed objection. But not to loſe the riſe it may afford me of illuſtrating the matter under conſideration, I am content briefly to conſider it, as far forth as my preſent diſquiſition may be concerned in it.

NOT to repeat then what has been already anſwered, I ſay further, that though I am ſo civil an adverſary, that I will allow the chymiſts, after the fire has done all its work, the uſe of fair water to make their extractions with, in ſuch caſes wherein the water does not cooperate with the fire to make the analyſis; yet ſince I grant this but upon ſuppoſition, that the water does only waſh off the ſaline particles, which the fire alone has before extricated in the analyzed body, it will not be reaſonable, that this conceſſion ſhould extend to other liquors, that may add to what they diſſolve, nor ſo much as to other caſes than thoſe newly mentioned: which limitation I deſire you would be pleaſed to bear in mind, till I ſhall anon have occaſion to make uſe of it. And this being thus premiſed, I ſhall proceed to obſerve,

FIRST, that many of the inſtances I propoſed in the preceding diſcourſe are ſuch, that the objection we are conſidering will not at all reach them. For fire can no more with the aſſiſtance of water, than without it, ſeparate any of the three principles, either from gold, ſilver, mercury, or ſome others of the concretes named above.

HENCE we may infer, that fire is not an univerſal analyzer of all mixt bodies, ſince of metals and minerals, wherein chymiſts have moſt exerciſed themſelves, there appear ſcarce any, which they are able to analyze by fire, nay, from which they can unqueſtionably ſeparate ſo much as any one of their hypoſtatical principles; which may well appear no ſmall diſparagement, as well to their hypotheſis, as to their pretenſions.

IT will alſo remain true, notwithſtanding the objection, that there may be other ways, than the wonted analyſis by fire, to ſeparate from a compound body ſubſtances as homogeneous as thoſe, that chymiſts ſcruple not to reckon among their *tria prima*, (as ſome of them, for brevity ſake, call their three principles.)

AND it appears, that by convenient additaments ſuch ſubſtances may be ſeparated by the help of the fire, as could not be ſo by the fire alone: witneſs the ſulphur of antimony.

AND laſtly, I muſt repreſent, that ſince it appears too, that the fire is but one of the inſtruments, that muſt be employed in the reſolution of bodies, we may reaſonably challenge the liberty of doing two things. For whenever any menſtruum or other additament is employed, together with the fire, to obtain a ſulphur or a ſalt from a body, we may well take the freedom to examine, whether or no that menſtruum do barely help to ſeparate the principle obtained by it, or whether there intervene not a coalition of the parts of the body wrought upon with thoſe of the menſtruum, whereby the produced concrete may be judged to reſult from the union of both. And it will be farther allowable for us to conſider, how far any ſubſtance, ſeparated by the help of ſuch additaments, ought to paſs for one of the *tria prima*; ſince by one way of handling the ſame mixt body, it may, according to the nature of the additaments, and the method of working upon it, be made to afford differing ſubſtances from it by other additaments, and another method, nay and (as may appear by what I formerly told you about tartar) differing from any of the ſubſtances, into which a concrete is diviſible by the fire without additaments, though, perhaps, thoſe additaments do not, as ingredients, enter the compoſition of the obtained body, but only diverſify the operation of the fire upon the concrete; and though that concrete by the fire alone may be divided into a number of differing ſubſtances, as great

as

as any of the chymiſts, that I have met with, teach us that of the elements to be. And having ſaid thus much (ſays *Carneades*) to the objection likely to be propoſed by ſome chymiſts, I am now to examine that, which I foreſee will be confidently preſſed by divers Peripateticks, who, to prove fire to be the true analyzer of bodies, will plead, That it is the very definition of heat given by *Ariſtotle*, and generally received, *congregare homogenea, & heterogenea ſegregare*, 'to aſſemble things of a 'reſembling, and disjoin thoſe of a differing 'nature.' To this I anſwer, that this effect is far from being ſo eſſential to heat, as it is generally imagined; for it rather ſeems, that the true and genuine property of heat is, to ſet a moving, and thereby to diſſociate the parts of bodies, and ſubdivide them into minute particles, without regard to their being homogeneous or heterogeneous; as is apparent in the boiling of water, the diſtillation of quickſilver, or the expoſing of bodies to the action of the fire, whoſe parts either are not (at leaſt in that degree of heat appear not) diſſimilar, where, all that the fire can do, is to divide the body into very minute parts, which are of the ſame nature with one another, and with their totum, as their reduction by condenſation evinces. And even when the fire ſeems moſt ſo *congregare homogenea, & ſegregare heterogenea*, it produces that effect but by accident; for the fire does but diſſolve the cement, or rather ſhatter the frame, or ſtructure, that kept the heterogeneous parts of bodies together, under one common form; upon which diſſolution the component particles of the mixt, being freed and ſet at liberty, do naturally, and oftentimes without any operation of the fire, aſſociate themſelves each with its like, or rather do take thoſe places, which their ſeveral degrees of gravity and levity, fixedneſs or volatility (either natural, or adventitious from the impreſſion of the fire) aſſign them. Thus in the diſtillation (for inſtance) of man's blood, the fire does firſt begin to diſſolve the nexus or cement of the body; and then the water, being the moſt volatile, and eaſy to be extracted, is either by the igneous atoms, or the agitation they are put into by the fire, firſt carried up, till forſaken by what carried it up, its weight ſinks it down, into the receiver: but all this while the other principles of the concrete remain unſever'd, and require a ſtronger degree of heat to make a ſeparation of its more fixt elements; and therefore the fire muſt be increaſed, which carries over the volatile ſalt and the ſpirit, they being, though believed to be differing principles, and though really of different conſiſtency, yet of an almoſt equal volatility. After them, as leſs fugitive, comes over the oil, and leaves behind the earth and the alcali, which being of an equal fixedneſs, the fire ſevers them not, for all the definition of the ſchools. And if into a red-hot earthen or iron retort you caſt the matter to be diſtilled, you may obſerve, as I have often done, that the predominant fire will carry up all the volatile elements confuſedly in one fume, which will afterwards take their places in the receiver, either according to the degree of their gravity, or according to the exigency of their reſpective textures; the ſalt adhering, for the moſt part, to the ſides and top, and the phlegm faſtening itſelf there too in great drops, the oil and ſpirit placing themſelves under, or above one another, according as their ponderouſneſs makes them ſwim or ſink. For it is obſervable, that though oil or liquid ſulphur be one of the elements ſeparated by this fiery analyſis, yet the heat, which accidentally unites the particles of the other volatile principles, has not always the ſame operation on this, there being divers bodies, which yield two oils, whereof the one ſinks to the bottom of that ſpirit, on which the other ſwims; as I can ſhew you in ſome oils of the ſame deer's blood, which are yet by me: nay, I can ſhew you two oils carefully made of the ſame parcel of human blood, which not only differ extremely in colour, but ſwim upon one another without mixture, and, if by agitation confounded, will of themſelves divorce again.

AND that the fire doth oftentimes divide bodies, upon the account, that ſome of their parts are more fixt, and ſome more volatile, how far ſoever either of theſe two may be from a pure elementary nature, is obvious enough, if men would but heed it in the burning of wood, which the fire diſſipates into ſmoke and aſhes: for not only the latter of theſe is confeſſedly made up of two ſuch differing bodies as earth and ſalt; but the former being condenſed into that ſoot, which adheres to our chimneys, diſcovers itſelf to contain both ſalt and oil, and ſpirit and earth, (and ſome portion of phlegm too) which being, all almoſt, equally volatile to that degree of fire, which forces them up, (the more volatile parts helping, perhaps, as well as the urgency of the fire, to carry up the more fixt ones, as I have often tried in dulcified colcothar, ſublimed by ſal armoniac blended with it) are carried up together, but may afterwards be ſeparated by other degrees of fire, whoſe orderly gradation allows the diſparity of their volatileneſs to diſcover it ſelf. Beſides, if differing bodies united into one maſs be both ſufficiently fixt, the fire finding no parts volatile enough to be expelled or carried up, makes no ſeparation at all; as may appear by a mixture of colliquated ſilver and gold, whoſe component metals may be eaſily ſever'd by aqua fortis or aqua regis (according to the predominancy of the ſilver or the gold) but in the fire alone, though vehement, the metals remain unſever'd, the fire only dividing the body into ſmaller particles (whoſe littleneſs may be argued from their fluidity) in which either the little nimble atoms of fire, or its briſk and numberleſs ſtrokes upon the veſſels, hinder reſt and continuity, without any ſequeſtration of elementary principles. Moreover, the fire ſometimes does not ſeparate, ſo much as unite, bodies of a differing nature; provided they be of an almoſt reſembling fixedneſs, and have in the figure of their parts an aptneſs, to coalition, as we ſee in the making of many plaiſters, ointments, *&c.* And in ſuch metalline mixtures as that made by melting

melting together two parts of clean braſs with one of pure copper, of which ſome ingenious tradeſmen caſt ſuch curious patterns (for gold and ſilver works) as I have ſometimes taken great pleaſure to look upon. Sometimes the bodies mingled by the fire are differing enough as to fixidity and volatility, and yet are ſo combined by the firſt operation of the fire, that it ſelf does ſcarce afterwards ſeparate them, but only pulverize them; whereof an inſtance is afforded us by the common preparation of mercurius dulcis, where the ſaline particles of the vitriol, ſea-ſalt, and ſometimes nitre, employed to make the ſublimate, do ſo unite themſelves with the mercurial particles made uſe of, firſt to make ſublimate, and then to dulcify it, that the ſaline and metalline parts ariſe together in many ſucceſſive ſublimations, as if they all made but one body. And ſometimes too, the fire does not only not ſever the differing elements of a body, but combine them ſo firmly, that nature her ſelf does very ſeldom, if ever, make unions leſs diſſoluble. For the fire meeting with ſome bodies exceedingly and almoſt equally fixt, inſtead of making a ſeparation, makes an union ſo ſtrict, that it ſelf, alone, is unable to diſſolve it; as we ſee, when an alcalizate ſalt and the terreſtrial reſidue of the aſhes are incorporated with pure ſand, and by vitrification made one permanent body, (I mean the coarſe or greeniſh ſort of glaſs) that mocks the greateſt violence of the fire, which though able to marry the ingredients of it, yet is not able to divorce them. I can ſhew you ſome pieces of glaſs, which I ſaw flow down from an earthen crucible purpoſely expoſed for a good while, with ſilver in it, to a very vehement fire. And ſome that deal much in the fuſion of metals inform me, that the melting of a great part of a crucible into glaſs is no great wonder in their furnaces. I remember, I have obſerved too in the melting of great quantities of iron out of the ore, by the help of ſtore of charcoal (for they affirm that ſea-coal will not yield a flame ſtrong enough) that by the prodigious vehemence of the fire, excited by vaſt bellows (made to play by great wheels turned about by water) part of the materials expoſed to it, was, inſtead of being analyzed, colliquated, and turned into a dark, ſolid, and very ponderous glaſs, and that in ſuch quantity, that in ſome places I have ſeen the very high-ways, near ſuch iron-works, mended with heaps of ſuch lumps of glaſs, inſtead of ſtones and gravel. And I have alſo obſerved, that ſome kind of fire-ſtone it ſelf, having been employed in furnaces wherein it was expoſed to very ſtrong and laſting fires, has had all its fixt parts ſo wrought on by the fire, as to be perfectly vitrified, which I have tried by forcing from it pretty large pieces of perfect and tranſparent glaſs. And leſt you might think, *Eleutherius*, that the queſtioned definition of heat may be demonſtrated, by the definition, which is wont to be given and acquieſced in, of its contrary quality, cold; whoſe property is taught to be *tam homogenea, quam heterogenea congregare*, give me leave to repreſent to you, that neither is this definition unqueſtionable; for not to mention the exceptions, which a logician, as ſuch, may take at it, I conſider, that the union of heterogeneous bodies, which is ſuppoſed to be the genuine production of cold, is not performed by every degree of cold. For we ſee, for inſtance, that in the urine of healthy men, when the liquor has been ſuffered a while to ſtand, the cold makes a ſeparation of the thinner part from the groſſer, which ſubſides to the bottom, and grows opacous there; whereas, if the urinal be warm, theſe parts readily mingle again, and the whole liquor becomes tranſparent as before. And when, by glaciation, wood, ſtraw, duſt, water, *&c.* are ſuppoſed to be united into one lump of ice, the cold does not cauſe any real union or adunation, (if I may ſo ſpeak) of theſe bodies, but only hardening the aqueous parts of the liquor into ice, the other bodies, being accidentally preſent in that liquor, are frozen up in it, but not really united. And accordingly, if we expoſe a heap of money, conſiſting of gold, ſilver and copper coins, or any other bodies of differing natures, which are deſtitute of aqueous moiſture, capable of congelation, to never ſo intenſe a cold, we find not, that theſe differing bodies are at all thereby ſo much as compacted, much leſs united together; and even in liquors themſelves we find phænomena, which induce us to queſtion the definition, which we are examining. If *Paracelſus* his authority were to be looked upon as a ſufficient proof in matters of this nature, I might here inſiſt on that proceſs of his, whereby he teaches, that the eſſence of wine may be ſever'd from the phlegm and ignoble part by the aſſiſtance of congelation. And becauſe much weight has been laid upon this proceſs, not only by Paracelſians, but other writers, ſome of whom ſeem not to have peruſed it themſelves, I ſhall give you the entire paſſage in the author's own words, as I lately found them in the ſixth book of his *Archidoxis*, an extract whereof I have yet about me; and it ſounds thus: *De vino ſciendum eſt, fæcem phlegmaque ejus eſſe mineram, & vini ſubſtantiam eſſe corpus, in quo conſervatur eſſentia, prout auri in auro latet eſſentia. Juxta quod practicam nobis ad memoriam ponimus, ut non obliviſcamur, ad hunc modum: Recipe Vinum vetuſtiſſimum & optimum, quod habere poteris, calore ſaporeque ad placitum; hoc in vas vitreum infundas, ut tertiam ejus partem impleat, & ſigillo Hermetis occluſum in equino ventre menſibus quatuor, & in continuato calore tencatur, qui non deficiat. Quo peracto, hyeme, cum frigus & gelu maxime ſæviunt, his per menſem exponatur, ut congeletur. Ad hunc modum frigus vini ſpiritum una cum ejus ſubſtantia protrudit in vini centrum, ac ſeparat a phlegmate: congelatum abjice; quod vero congelatum non eſt, id ſpiritum cum ſubſtantia eſſe judicato. Hunc in pelicanum poſitum in arenæ digeſtione non adeo calida per aliquod tempus manere finito; poſtmodum eximito vini magiſterium, de quo locuti ſumus.*

BUT I dare not, *Eleutherius*, lay much weight upon this proceſs, becauſe I have found, that, if it were true, it would be but ſeldom practicable in this country upon the beſt wine: for

though this preſent winter hath been extraordinary cold, yet in very keen froſts, accompanied with laſting ſnows, I have not been able in any meaſure to freeze a thin phial full of ſack; and even with ſnow and ſalt I could freeze little more than the ſurface of it; and I ſuppoſe, *Eleutherius*, that it is not every degree of cold, that is capable of congealing liquors, which is able to make ſuch an analyſis (if I may ſo call it) of them by ſeparating their aqueous and ſpirituous parts: for I have ſometimes, though not often, frozen ſeverally red-wine, urine and milk, but could not obſerve the expected ſeparation. And the Dutchmen, that were forced to winter in that icy region near the arctick circle, called *Nova Zembla*, although they relate, as we ſhall ſee below, that there was a ſeparation of parts made in their frozen beer about the middle of *November*, yet of the freezing of their ſack in *December* following they give but this account: *Yea and our ſack, which is ſo hot, was frozen very hard, ſo that when we were every man to have his part, we were forced to melt it in the fire; which we ſhared every ſecond day, about half a pint for a man, wherewith we were forced to ſuſtain our ſelves.* In which words they imply not, that their ſack was divided by the froſt into differing ſubſtances, after ſuch manner as their beer had been. All which notwithſtanding, *Eleutherius*, ſuppoſe that it may be made to appear, that even cold ſometimes may *congregare homogenea, & heterogenea ſegregare*; and to manifeſt this, I may tell you, that I did once, purpoſely, cauſe to be decocted in fair water a plant abounding with ſulphureous and ſpirituous parts; and having expoſed the decoction to a keen north-wind in a very froſty night, I obſerved, that the more aqueous parts of it were turned by the next morning into ice, towards the innermoſt part of which, the more agile and ſpiritous parts, as I then conjectured, having retreated, to ſhun, as much as might be, their invironing enemy, they had there preſerved themſelves unfrozen in the form of a high coloured liquor; the aqueous and ſpirituous parts having been ſo ſlightly (blended rather than) united in the decoction, that they were eaſily ſeparable by ſuch a degree of cold, as would not have been able to have divorced the parts of urine or wine, which by fermentation or digeſtion are wont, as trial has informed me, to be more intimately aſſociated each with other. But I have already intimated, *Eleutherius*, that I ſhall not inſiſt on this experiment, not only becauſe, having made it but once, I may poſſibly have been miſtaken in it; but alſo (and that principally) becauſe of that much more full and eminent experiment of the ſeparative virtue of extreme cold, that was made againſt their wills, by the forementioned Dutchmen that wintered in *Nova Zembla*; the relation of whoſe voyage being a very ſcarce book, it will not be amiſs to give you that memorable part of it, which concerns our preſent theme, as I cauſed the paſſage to be extracted out of the Engliſhed voyage it ſelf.

'GERARD DE VEER, *John Cornelyſon* and 'others, ſent out of *Amſterdam*, *Anno Dom.* '1596, being forced by unſeaſonable weather 'to winter in *Nova Zembla*, near *Ice-haven*; 'on the thirteenth of *October*, three of us (ſays 'the relation) went aboard the ſhip, and laded 'a ſled with beer; but when we had laden it, 'thinking to go to our houſe with it, ſuddenly 'there aroſe ſuch a wind, and ſo great a ſtorm 'and cold, that we were forced to go into the 'ſhip again, becauſe we were not able to ſtay 'without; and we could not get the beer into 'the ſhip again, but were forced to let it ſtand 'without upon the ſled. The fourteenth, as 'we came out of the ſhip, we found the barrel 'of beer ſtanding upon the ſled, but it was 'faſt frozen at the heads; yet by reaſon of 'the great cold, the beer, that purged out, froze 'as hard upon the ſide of the barrel, as if it 'had been glued thereon: and in that ſort 'we drew it to our houſe, and ſet the barrel 'an end, and drank it up; but firſt we were 'forced to melt the beer, for there was ſcarce 'any unfrozen beer in the barrel: but in that 'thick yeaſt, that was unfrozen, lay the 'ſtrength of the beer, ſo that it was too ſtrong 'to drink alone, and, that which was frozen 'taſted like water; and being melted, we 'mixed one with the other, and ſo drank it; 'but it had neither ſtrength nor taſte.'

AND on this occaſion I remember, that having, the laſt very ſharp winter, purpoſely tried to freeze, among other liquors, ſome beer moderately ſtrong, in glaſs-veſſels, with ſnow and ſalt, I obſerved, that there came out of the neck a certain thick ſubſtance, which, it ſeems, was much better able than the reſt of the liquor (that I found turned into ice) to reſiſt a froſt; and which, by its colour and conſiſtence, ſeemed manifeſtly enough to be yeaſt; whereat, I confeſs, I ſomewhat marvelled, becauſe I did not either diſcern by the taſte, or find by enquiry, that the beer was at all too new, to be very fit to be drank. I might confirm the Dutchmen's relation, by what happened a while ſince to a near friend of mine, who complained to me, that having brewed ſome beer or ale for his own drinking in *Holland* (where he then dwelt) the keenneſs of the late bitter winter froze the drink, ſo as to reduce it into ice, and a ſmall proportion of a very ſtrong and ſpirituous liquor. But I muſt not entertain you any longer concerning cold, not only becauſe you may think I have but loſt my way into a theme, which does not directly belong to my preſent undertaking; but becauſe I have already enlarged my ſelf too much, upon the firſt conſideration I propoſed, though it appears ſo much a paradox, that it ſeemed to require, that I ſhould ſay much to keep it from being thought a meer extravagance: yet ſince I undertook but to make the common aſſumption of our Chymiſts and Ariſtotelians appear queſtionable, I hope I have ſo performed that taſk, that I may now proceed to my following conſiderations, and inſiſt leſs on them than I have done on the firſt.

THE SCEPTICAL CHYMIST:

PART II.

THE ſecond conſideration I deſire to have notice taken of, is this; that it is not ſo ſure, as both Chymiſts and Ariſtotelians are wont to think it, that every ſeemingly ſimilar or diſtinct ſubſtance, that is ſeparated from a body by the help of the fire, was pre-exiſtent in it, as a principle or element of it.

THAT I may not make this paradox a greater than needs muſt, I will firſt briefly explain what the propoſition means, before I proceed to argue for it.

AND, I ſuppoſe, you will eaſily believe, that I do not mean, that any thing is ſeparable from a body by fire, that was not materially pre-exiſtent in it: for it far exceeds the power of meerly natural agents, and conſequently of the fire, to produce anew ſo much as one atom of matter, which they can but modify and alter, not create; which is ſo obvious a truth, that almoſt all ſects of philoſophers have denied the power of producing matter to ſecond cauſes, and the Epicureans and ſome others have done the like, in reference to their gods themſelves.

NOR does the propoſition peremptorily deny, but that ſome things obtained by the fire from a mixed body may have been more than barely-materially pre-exiſtent in it; ſince there are concretes, which before they be expoſed to the fire, afford us ſeveral documents of their abounding, ſome with ſalt, and others with ſulphur. For it will ſerve the preſent turn, if it appear, that divers things obtained from a mixed body expoſed to the fire were not its ingredients before; for, if this be made to appear, it will be rational enough to ſuſpect, that chymiſts may deceive themſelves, and others, in concluding reſolutely and univerſally, thoſe ſubſtances to be the elementary ingredients of bodies barely ſeparated by the fire, of which it yet may be doubted, whether there be ſuch or no; at leaſt till ſome other argument, than that drawn from the analyſis, be brought to reſolve the doubt.

THAT then, which I mean by the propoſition I am explaining, is, that it may without abſurdity be doubted, whether or no the differing ſubſtances obtainable from a concrete diſſipated by the fire were ſo exiſtent in it, in that form (at leaſt, as to their minute parts) wherein we find them, when the analyſis is over, that the fire did only disjoin and extricate the corpuſcles of one principle from thoſe of the other, wherewith before they were blended.

HAVING thus explained my propoſition, I ſhall endeavour to do two things, to prove it; the firſt of which is to ſhew, that ſuch ſubſtances, as chymiſts call principles, may be produced *de novo* (as they ſpeak.) And the other is to make it probable, that by the fire we may actually obtain from ſome mixed bodies ſuch ſubſtances, as were not, in the newly-expounded ſenſe, pre-exiſtent in them.

TO begin then with the firſt of theſe, I conſider, that if it be as true, as it is probable, that compounded bodies differ from one another but in the various textures reſulting from the bigneſs, ſhape, motion, and contrivance of their ſmall parts, it will not be irrational to conceive, that one and the ſame parcel of the univerſal matter may, by various alterations and contextures, be brought to deſerve the name, ſometimes of a ſulphureous, and ſometimes of a terrene, or aqueous body. And this I could more largely explicate, but that our friend Mr. *Boyle* has promiſed us ſomething about qualities, wherein the theme I now willingly reſign him, will, I queſtion not, be ſtudiouſly inquired into. Wherefore, what I ſhall now advance in favour of what I have lately delivered, ſhall be deduced from experiments made divers years ſince. The firſt of which would have been much more conſiderable, but that by ſome intervening accidents I was neceſſitated to loſe the beſt time of the year, for a trial of the nature of that I deſigned; it being about the middle of *May*, before I was able to begin an experiment, which ſhould have then been two months old; but ſuch as it was, it will not, perhaps, be impertinent to give you this narrative of it. At the time newly mentioned, I cauſed my gardener (being by urgent occaſions hindered from being preſent my ſelf) to dig out a convenient quantity of good earth, and dry it well in an oven, to weigh it, to put in an earthen-pot almoſt level with the ſurface of the ground, and to ſet in it a ſelected ſeed, he had before received from me, for that purpoſe, of ſquaſh, which is an Indian kind of pompion, that grows apace; this ſeed I ordered him to water only with rain or ſpring-water. I did not, (when my occaſions permitted me to viſit it) without delight behold how faſt it grew, though unſeaſonably ſown; but the haſtening winter hindered it from attaining any thing near its due and wonted magnitude, (for I found the ſame autumn, in my garden, ſome of thoſe plants, by meaſure, as big about as my middle) and made me order the having it taken up; which about the middle of *October* was carefully done by the ſame gardener, who a while after ſent me this account of it: *I have weighed the pompion with the ſtalk and leaves, all which weighed three pound wanting a quarter; then I took the earth, baked it as formerly, and found it juſt as much as I did at firſt, which made me think, I had not dried it ſufficiently.*

Then

then I put it into the oven twice more, after the bread was drawn, and weighed it the ſecond time, but found it ſhrink little or nothing.

BUT to deal candidly with you, *Eleutherius*, I muſt not conceal from you the event of another experiment of this kind made this preſent ſummer, wherein the earth ſeems to have been much more waſted; as may appear by the following account, lately ſent me by the ſame gardener, in theſe words: *To give you an account of your cucumbers, I have gained two indifferent fair ones, the weight of them is ten pound and a half, the branches with the roots weighed four pounds wanting two ounces; and when I had weighed them, I took the earth, and baked it in ſeveral ſmall earthen diſhes in an oven; and when I had ſo done, I found the earth wanted a pound and a half of what it was formerly; yet I was not ſatisfied, doubting the earth was not dry: I put it into an oven the ſecond time, (after the bread was drawn,) and after I had taken it out and weighed it, I found it to be the ſame weight. So I ſuppoſe there was no moiſture left in the earth. Neither do I think, that the pound and half, that was wanting, was drawn away by the cucumber, but a great part of it, in the ordering, was in duſt (and the like) waſted: (the cucumbers are kept by themſelves, leſt you ſhould ſend for them.)* But yet in this trial, *Eleutherius*, it appears, that though ſome of the earth, or rather the diſſoluble ſalt harboured in it, were waſted, the main body of the plant conſiſted of tranſmuted water. And I might add, that a year after I cauſed the formerly mentioned experiment, touching large pompions, to be reiterated, with ſo good ſucceſs, that if my memory does not much miſ-inform me, it did not only much ſurpaſs any, that I made before, but ſeemed ſtrangely to conclude what I am pleading for; though (by reaſon, I have unhappily loſt the particular account my gardener writ me up of the circumſtances) I dare not inſiſt upon them. The like experiment may be as conveniently tried with the ſeeds of any plant, whoſe growth is haſty, and its ſize bulky. If tobacco will in theſe cold climates grow well in earth undunged, it would not be amiſs to make a trial with it; for it is an annual plant, that ariſes where it proſpers, ſometimes as high as a tall man, and I have had leaves of it in my garden, near a foot and a half broad. But the next time I try this experiment, it ſhall be with ſeveral ſeeds of the ſame ſort, in the ſame pot of earth, that ſo the event may be the more conſpicuous. But, becauſe every body has not conveniency of time and place for this experiment neither, I made, in my chamber, ſome ſhorter and more expeditious trials. I took a top of ſpearmint, about an inch long, and put it into a good phial full of ſpring water, ſo as the upper part of the mint was above the neck of the glaſs, and the lower part immerſed in the water; within a few days this mint began to ſhoot forth roots into the water, and to diſplay its leaves, and aſpire upwards; and in a ſhort time it had numerous roots and leaves, and theſe very ſtrong and fragrant of the odour of the mint; but the heat of my chamber, as I ſuppoſe, killed the plant, when it was grown to have a pretty thick ſtalk, which with the various and ramified roots, which it ſhot into the water as if it had been earth, preſented in its tranſparent flower-pot a ſpectacle not unpleaſant to behold. The like I tried with ſweet-marjoram; and I found the experiment ſucceed alſo, though ſomewhat more ſlowly, with balm and penyroyal, to name now no other plants. And one of theſe vegetables, cheriſhed only by water, having obtained a competent growth, I did, for trial's ſake, cauſe to be diſtilled in a ſmall retort, and thereby obtained ſome phlegm, a little empyreumatical ſpirit, a ſmall quantity of aduſt oil, and a *caput mortuum*; which appearing to be a coal, I concluded it to conſiſt of ſalt and earth: but the quantity of it was ſo ſmall, that I forbore to calcine it. The water I uſed to nouriſh this plant was not ſhifted nor renewed; and I choſe ſpring-water rather than rain-water, becauſe the latter is more diſcernably a kind of *πανσπερμία*, which, though it be granted to be freed from groſſer mixtures, ſeems yet to contain in it, beſides the ſteams of ſeveral bodies wandering in the air, which may be ſuppoſed to impregnate it, a certain ſpirituous ſubſtance, which may be extracted out of it, and is by ſome miſtaken for the ſpirit of the world corporified, upon what grounds, and with what probability, I may elſewhere, perchance, but muſt not now, diſcourſe to you.

BUT perhaps I might have ſaved a great part of my labour. For I find, that *Helmont* (an author more conſiderable for his experiments, than many learned men are pleaſed to think him) having had an opportunity to proſecute an experiment much of the ſame nature with thoſe I have been now ſpeaking of, for five years together, obtained at the end of that time ſo notable a quantity of tranſmuted water, that I ſhould ſcarce think it fit to have his experiment, and mine mentioned together, were it not, that the length of time requiſite to this may deter the curioſity of ſome, and exceed the leiſure of others; and partly, that ſo paradoxical a truth, as that, which theſe experiments ſeem to hold forth, needs to be confirmed by more witneſſes than one, eſpecially ſince the extravagancies and untruths, to be met with in *Helmont*'s treatiſe of the magnetic cure of wounds, have made his teſtimonies ſuſpected in his other writings; though as to ſome of the unlikely matters of fact he delivers in them, I might ſafely undertake to be his compurgator. But that experiment of his, which I was mentioning to you, he ſays, was this: he took 200 pound of earth dried in an oven, and having put it into an earthen veſſel, and moiſtened it with rain-water, he planted in it the trunk of a willow-tree of five pound weight; this he watered, as need required, with rain or with diſtilled water; and to keep the neighbouring earth from getting into the veſſel, he employed a plate of iron tinned over and perforated with many holes. Five years being effluxed, he took out the tree, and weighed it, and (with computing the leaves, that fell during four autumns) he found it to weigh

169 pound, and about three ounces. And having again dryed the earth it grew in, he found it want of its former weight of 200 pound, about a couple only of ounces; ſo that 164 pound of the roots, wood, and bark, which conſtituted the tree, ſeem to have ſprung from the water. And though it appears not, that *Helmont* had the curioſity to make any analyſis of this plant, yet what I lately told you I did to one of the vegetables I nouriſhed with water only, will I ſuppoſe keep you from doubting, that if he had diſtilled this tree, it would have afforded him the like diſtinct ſubſtances as another vegetable of the ſame kind. I need not ſubjoin, that I had it alſo in my thoughts to try, how experiments, to the ſame purpoſe with thoſe I related to you, would ſucceed in other bodies than vegetables, becauſe importunate avocations having hitherto hindered me from putting my deſign in practice, I can yet ſpeak but conjecturally of the ſucceſs: but the beſt is, that the experiments already made and mentioned to you need not the aſſiſtance of new ones, to verify as much, as my preſent taſk makes it concern me to prove by experiments of this nature.

ONE would ſuſpect (ſays *Eleutherius* after his long ſilence) by what you have been diſcourſing, that you are not far from *Helmont*'s opinion about the origination of compound bodies, and perhaps too diſlike not the arguments, which he imploys to prove it.

WHAT Helmontian opinion, and what arguments do you mean? (aſks *Carneades*)

WHAT you have been newly diſcourſing (replies *Eleutherius*) tells us, that you cannot but know, that this bold and acute Spagyriſt ſcruples not to aſſert, that all mixt bodies ſpring from one element; and that vegetables, animals, marchaſites, ſtones, metals, *&c.* are materially but ſimple water diſguiſed into theſe various forms, by the plaſtick or formative vertue of their ſeeds. And as for his reaſons, you may find divers of them ſcattered up and down his writings; the conſiderableſt of which ſeem to be theſe three; the ultimate reduction of mixt bodies into inſipid water, the viciſſitude of the ſuppoſed elements, and the production of perfectly mixt bodies out of ſimple water. And firſt he affirms, that the *ſal circulatus Paracelſi*, or his liquor alkaheſt, does adequately reſolve plants, animals, and minerals into one liquor or more, according to their ſeveral internal diſparities of parts, (without *caput mortuum*, or the deſtruction of their ſeminal vertues;) and that the alkaheſt being abſtracted from theſe liquors in the ſame weight and virtue wherewith it diſſolved them, the liquors may by frequent cohobations from chalk or ſome other idoneous matter, be totally deprived of their ſeminal endowments, and return at laſt to their firſt matter, inſipid water: ſome other ways he propoſes here and there to diveſt ſome particular bodies of their borrowed ſhapes, and make them remigrate to their firſt ſimplicity. The ſecond topick, whence *Helmont* draws his arguments, to prove water to be the material cauſe of mixt bodies, I told you was this, that the other ſuppoſed elements may be tranſmuted into one another. But the experiments by him here and there produced on this occaſion are ſo uneaſy to be made and to be judged of, that I ſhall not inſiſt on them; not to mention, that if they were granted to be true, his inference from them is ſomewhat diſputable. And therefore I ſhall paſs on to tell you, that as, in his firſt argument, our paradoxical author endeavours to prove water the ſole element of mixt bodies, by their ultimate reſolution, when by his alkaheſt, or ſome other conquering agent, the ſeeds have been deſtroyed, which diſguiſed them; or when by time thoſe ſeeds are wearied, or exantlated, or unable to act their parts upon the ſtage of the univerſe any longer; ſo in his third argument he endeavours to evince the ſame concluſion, by the conſtitution of bodies, which he aſſerts to be nothing but water ſubdued by ſeveral virtues. Of this he gives here and there in his writings ſeveral inſtances, as to plants and animals; but divers of them being difficult either to be tried or to be underſtood, and others of them being not altogether unobnoxious to exceptions, I think you have ſingled out the principal and leſs queſtionable experiment, when you lately mentioned that of the willow-tree. And having thus, continues *Eleutherius*, to anſwer your queſtion, given you a ſummary account of what, I am confident, you know better than I do, I ſhall be very glad to receive your ſenſe of it, if the giving it me will not too much divert you from the proſecution of your diſcourſe.

THAT *if* (replies *Carneades*) was not needleſsly annexed: for thoroughly to examine ſuch an hypotheſis and ſuch arguments, would require ſo many conſiderations, and conſequently ſo much time, that I ſhould not now have the leiſure to perfect ſuch a digreſſion, and much leſs to finiſh my principal diſcourſe. Yet thus much I ſhall tell you at preſent, that you need not fear my rejecting this opinion for its novelty; ſince, however the Helmontians may, in compliment to their maſter, pretend it to be a new diſcovery, yet though the arguments be for the moſt part his, the opinion it ſelf is very antient: for *Diogenes Laertius* and divers other authors ſpeak of *Thales*, as the firſt among the *Grecians*, that made diſquiſitions upon nature. And of this *Thales*, I remember, *Tully* informs us, that he taught all things were at firſt made of water. And it ſeems by *Plutarch* and *Juſtin Martyr*, that the opinion was ancienter than he: for they tell us, that he uſed to defend his tenet by the teſtimony of *Homer*. And a Greek author, the ſcholiaſt of *Apollonius*, upon theſe words,

De naturâ Deorum.

Ἐξ ἰλύος ἐβλάστησε χθὼν ἅπασα. Argonaut. 4.
The earth of ſlime was made,

affirms (out of *Zeno*) that the chaos, whereof all things were made, was, according to *Heſiod*, water; which, ſettling firſt, became ſlime, and then condenſed into ſolid earth. And the ſame opinion about the generation of ſlime ſeems to have been entertained by *Orpheus*, out of whom one of the ancients cites this teſtimony, Athenagoras. Ἐκ

Ἐκ τοῦ ὕδατος ἰλὺς κατέστη.
Of water ſlime was made.

It ſeems alſo by what is delivered in * *Strabo* out of another author concerning the Indians, that they likewiſe held, that all things had differing beginnings, but that, of which the world was made, was water. And the like opinion has been by ſome of the ancients aſcribed to the Phenicians, from whom *Thales* himſelf is conceived to have borrowed it; as probably the Greeks did much of theology, and, as I am apt to think, of their philoſophy too; ſince the deviſing of the atomical hypotheſis commonly aſcribed to *Leucippus* and his diſciple *Democritus* is by learned men attributed to one *Moſchus* a Phenician. And poſſibly the opinion is yet ancienter than ſo; for it is known, that the Phenicians borrowed moſt of their learning from the Hebrews. And among thoſe, that acknowledge the books of *Moſes*, many have been inclined to think water to have been the primitive and univerſal matter, by peruſing the beginning of *Geneſis*, where the waters ſeem to be mentioned as the material cauſe, not only of ſublunary compound bodies, but of all thoſe, that make up the univerſe; whoſe component parts did orderly, as it were, emerge out of that vaſt abyſs, by the operation of the ſpirit of God, who is ſaid to have been moving himſelf, as hatching females do, (as the original Deuter. xxxii. 11. Jerem. xxiii. 9. מרחפת, *Merahephet*, is ſaid to import, and it ſeems to ſignify, in one of the two other places, wherein alone I have met with it in the Hebrew bible) upon the face of the waters; which being, as may be ſuppoſed, divinely impregnated with the ſeeds of all things, were by that productive incubation qualified to produce them. But you, I preſume, expect, that I ſhould diſcourſe of this matter like a naturaliſt, not a philologer. Wherefore I ſhall add, to countenance *Helmont*'s opinion, that whereas he gives not, that I remember, any inſtance of any mineral body, nor ſcarce of any animal, generated of water, a French chymiſt, Monſieur *de Rochas*, has preſented his readers an experiment, which if it were punctually ſuch as he has delivered it, is very notable. He then, diſcourſing of the generation of things according to certain chymical and metaphorical notions (which I confeſs are not to me intelligible) ſets down, among divers ſpeculations not pertinent to our ſubject, the following narrative, which I ſhall repeat to you the ſenſe of in Engliſh, with as little variation from the literal ſenſe of the French words, as my memory will enable me. *Having* (ſays he) *diſcerned ſuch great wonders by the natural operation of water, I would know what may be done with it by art imitating nature. Wherefore I took water, which I well knew not to be compounded, nor to be mixed with any other thing than that ſpirit of life* (whereof he had ſpoken before) *and with a heat artificial, continual and proportionate, I prepared and diſpoſed it by the above mentioned graduations of coagulation, congelation, and fixation, until it was turned into earth, which earth produced animals, vegetables and minerals. I tell not what animals, vegetables and minerals, for that is reſerved for another occaſion: but the animals did move of themſelves, eat,* &c.— *and by the true anatomy I made of them, I found, that they were compoſed of much ſulphur, little mercury, and leſs ſalt.—The minerals began to grow and increaſe by converting into their own nature one part of the earth thereunto diſpoſed; they were ſolid and heavy. And by this truly demonſtrative ſcience, namely chymiſtry, I found, that they were compoſed of much ſalt, little ſulphur, and leſs mercury.*

BUT (ſays *Carneades*) I have ſome ſuſpicions concerning this ſtrange relation, which make me unwilling to declare an opinion of it, unleſs I were ſatisfied concerning divers material circumſtances, that our author has left unmentioned; though, as for the generation of living creatures, both vegetable and ſenſitive, it needs not ſeem incredible, ſince we find, that our common water (which indeed is often impregnated with variety of ſeminal principles and rudiments) being long kept in a quiet place, will putrify and ſtink, and then perhaps too, produce moſs and little worms, or other inſects, according to the nature of the ſeeds that were lurking in it. I muſt likewiſe deſire you to take notice, that as *Helmont* gives us no inſtance of the production of minerals out of water, ſo the main argument, that he employs to prove, that they and other bodies may be reſolved into water, is drawn from the operations of his alkaheſt, and conſequently cannot be ſatisfactorily examined by you and me.

YET certainly (ſays *Eleutherius*) you cannot but have ſomewhat wondered as well as I, to obſerve, how great a ſhare of water goes to the making up of divers bodies, whoſe diſguiſes promiſe nothing near ſo much. The diſtillation of eels, though it yielded me ſome oil, and ſpirit, and volatile ſalt, beſides the *caput mortuum*, yet were all theſe ſo diſproportionate to the phlegm, that came from them, (and in which at firſt they boiled as in a pot of water) that they ſeemed to have been nothing but coagulated phlegm; which does likewiſe ſtrangely abound in vipers, though they are eſteemed very hot in operation, and will in a convenient air ſurvive ſome days the loſs of their heads and hearts, ſo vigorous is their vivacity. Man's blood it ſelf, as ſpirituous and as elaborate a liquor as it is reputed, does ſo abound in phlegm, that, the other day, diſtilling ſome of it on purpoſe to try the experiment (as I had formerly done in deer's blood) out of about ſeven ounces and a half of pure blood we drew near ſix ounces of phlegm, before any of the more operative principles began to ariſe and invite us to change the receiver. And to ſatisfy my ſelf, that ſome of theſe animal phlegms were void enough of ſpirit to deſerve that name, I would not content my ſelf to taſte them only, but fruitleſsly poured on them acid liquors, to try if they contained any volatile ſalt or ſpirit, which (had there been any there) would probably have diſcovered it ſelf by making an ebullition with the affuſed liquor. And now I mention corroſive ſpirits, I am minded to inform

* *Univerſarum rerum primordia diverſa eſſe, faciendi autem mundi initium aquam.* Strabo Geograph. Lib. 15. *circa medium.*

form you, that though they ſeem to be nothing elſe but fluid ſalts, yet they abound in water, as you may obſerve, if either you entangle, and ſo fix their ſaline part, by making them corrode ſome idoneous body, or elſe if you mortify it with a contrary ſalt; as I have very manifeſtly obſerved in the making a medicine ſomewhat like *Helmont*'s Balſamus Samech, with diſtilled vinegar inſtead of ſpirit of wine, wherewith he prepare it. For you would ſcarce believe (what I have lately obſerved) that of that acid ſpirit, the ſalt of tartar, from which it is diſtilled, will, by mortifying and retaining the acid ſalt, turn into worthleſs phlegm near twenty times its weight; before it be ſo fully impregnated as to rob no more diſtilled vinegar of its ſalt. And though ſpirit of wine exquiſitely rectified ſeem of all liquors to be the moſt free from water, it being ſo igneous, that it will flame all away without leaving the leaſt drop behind it, yet even this fiery liquor is by *Helmont* not improbably affirmed, in caſe what he relates be true, to be materially water, under a ſulphureous diſguiſe: for according to him, in the making that excellent medicine, *Paracelſus* his Balſamus Samech, (which is nothing but ſal tartari dulcified, by diſtilling from it ſpirit of wine till the ſalt be ſufficiently glutted with its ſulphur, and till it ſuffer the liquor to be drawn off, as ſtrong as it was poured on) when the ſalt of tartar from which it is diſtilled hath retained, or deprived it of the ſulphureous parts of the ſpirit of wine, the reſt, which is incomparably the greater part of the liquor, will remigrate into phlegm. I added that clauſe [*In caſe what he relates be true*] becauſe I have not as yet ſufficiently tried it my ſelf. But not only ſomething of experiment keeps me from thinking it, as many chymiſts do, abſurd, (though I have, as well as they, in vain tried it with ordinary ſalt of tartar) but beſides that *Helmont* often relates it, and draws conſequences from it; a perſon noted for his ſoberneſs and ſkill in ſpagyrical preparations, having been aſked by me, whether the experiment might not be made to ſucceed, if the ſalt and ſpirit were prepared, according to a way ſuitable to my principles, he affirmed to me, that he had that way, I propoſed, made *Helmont*'s experiment ſucceed very well, without adding any thing to the ſalt and ſpirit. But our way is neither ſhort nor eaſy.

I HAVE indeed (ſays *Carneades*) ſometimes wondered to ſee, how much phlegm may be obtained from bodies by the fire. But concerning that phlegm I may anon have occaſion to note ſomething, which I therefore ſhall not now anticipate. But to return to the opinion of *Thales*, and of *Helmont*, I conſider, that ſuppoſing the alkaheſt could reduce all bodies into water, yet whether that water, becauſe inſipid, muſt be elementary, may not groundleſsly be doubted: for I remember the candid and eloquent *Petrus Laurembergius*, in his notes upon *Sala*'s aphoriſms, affirms, that he ſaw an inſipid menſtruum, that was a powerful diſſolvent, and (if my memory does not much miſ-inform me) could diſſolve gold. And the water, which may be drawn from quickſilver without addition, though it be almoſt taſteleſs, you will, I believe, think of a differing nature from ſimple water, eſpecially if you digeſt in it appropriated minerals. To which I ſhall add but this, that this conſideration may be further extended. For I ſee no neceſſity to conceive, that the water mentioned in the beginning of *Geneſis*, as the univerſal matter, was ſimple and elementary water; ſince though we ſhould ſuppoſe it to have been an agitated congeries or heap conſiſting of a great variety of ſeminal principles and rudiments, and of other corpuſcles fit to be ſubdued and faſhioned by them, it might yet be a body fluid like water, in caſe the corpuſcles, it was made up of, were by their Creator made ſmall enough, and put into ſuch an actual motion, as might make them glide along one another. And as we now ſay, the ſea conſiſts of water, (notwithſtanding the ſaline, terreſtrial, and other bodies mingled with it,) ſuch a liquor may well enough be called water, becauſe that was the greateſt of the known bodies, whereunto it was like; though, that a body may be fluid enough to appear a liquor, and yet contain corpuſcles of a very differing nature, you will eaſily believe, if you but expoſe a good quantity of vitriol in a ſtrong veſſel to a competent fire. For although it contains both aqueous, earthy, ſaline, ſulphureous, and metalline corpuſcles, yet the whole maſs will at firſt be fluid like water, and boil like a ſeething-pot.

I MIGHT eaſily (continues *Carneades*) enlarge my ſelf on ſuch conſiderations, if I were now obliged to give you my judgment of the Thaleſian and Helmontian hypotheſis. But, whether or no we conclude, that all things were at firſt generated of water, I may deduce from what I have tried concerning the growth of vegetables, nouriſhed with water, all that I now propoſed to my ſelf or need at preſent to prove; namely, that ſalt, ſpirit, earth, and even oil (though that be thought of all bodies the moſt oppoſite to water) may be produced out of water; and conſequently, that a Chymical principle, as well as a Peripatetick element, may (in ſome caſes) be generated anew, or obtained from ſuch a parcel of matter, as was not endowed with the form of ſuch a principle or element before.

AND having thus, *Eleutherius*, evinced, that it is poſſible, that ſuch ſubſtances as thoſe, that chymiſts are wont to call their *tria prima*, may be generated anew; I muſt next endeavour to make it probable, that the operation of the fire does actually (ſometimes) not only divide compounded bodies into ſmall parts, but compound thoſe parts after a new manner: whence conſequently, for aught we know, there may emerge as well ſaline and ſulphureous ſubſtances, as bodies of other textures. And, perhaps, it will aſſiſt us in our inquiry after the effects of the operations of the fire upon other bodies, to conſider a little, what it does to thoſe mixtures, which being productions of the art of man, we beſt know the compoſition of. You may then be pleaſed to take notice, that though ſoap is made up by the ſoap-boilers of oil or greaſe,

greaſe, and ſalt, and water diligently incorporated together; yet if you expoſe the maſs they conſtitute to a gradual fire in a retort, you ſhall then indeed make a ſeparation, but not of the ſame ſubſtances, that were united into ſoap, but of others of a diſtant and yet not an elementary nature, and eſpecially of an oil very ſharp and fœtid, and of a very differing quality from that, which was imployed to make the ſoap. So, if you mingle in a due proportion ſal armoniac with quick-lime, and, diſtil them by degrees of fire, you ſhall not divide the ſal armoniac from the quick-lime, though the one be a volatile, and the other a fixed ſubſtance, but that, which will aſcend, will be a ſpirit much more fugitive, penetrant, and ſtinking, than ſal armoniac; and there will remain with the quick-lime all, or very near all the ſea-ſalt, that concurred to make up the ſal armoniack; concerning which ſea-ſalt I ſhall, to ſatisfy you how well it was united to the lime, inform you, that I have, by making the fire at length very vehement, cauſed both the ingredients to melt in the retort itſelf into one maſs, and ſuch maſſes are apt to relent in the moiſt air. If it be here objected, that theſe inſtances are taken from factitious concretes, which are more compounded than thoſe, which nature produces; I ſhall reply, that beſides that I have mentioned them as much to illuſtrate what I propoſed, as to prove it; it will be difficult to evince, that nature herſelf does not make decompounded bodies; I mean, mingle together ſuch mixt bodies, as are already compounded of elementary, or rather of more ſimple ones. For vitriol (for inſtance) though I have ſometimes taken it out of mineral earths, where nature had without any aſſiſtance of art prepared it to my hand, is really, though chymiſts are pleaſed to reckon it among ſalts, a decompounded body, conſiſting (as I ſhall have occaſion to declare anon) of a terreſtrial ſubſtance, of a metal, and alſo of at leaſt one ſaline body, of a peculiar, and not elementary nature. And we ſee alſo in animals, that their blood may be compoſed of divers very differing mixt bodies, ſince we find it obſerved, that divers ſea-fowl taſte rank of the fiſh, on which they ordinarily feed; and *Hippocrates* himſelf obſerves, that a child may be purged by the milk of the nurſe, if ſhe have taken elaterium; which argues, that the purging corpuſcles of the medicament concur to make up the milk of the nurſe; and that white liquor is generally by phyſicians ſuppoſed to be but blanched and altered blood. And I remember I have obſerved, not far from the *Alps*, that at a certain time of the year the butter of that country was very offenſive to ſtrangers, by reaſon of the rank taſte of a certain herb, whereon the cows were then wont plentifully to feed. But (proceeds *Carneades*) to give you inſtances of another kind, to ſhew, that things may be obtained by the fire from a mixt body, that were not pre-exiſtent in it, let me remind you, that from many vegetables there may without any addition be obtained glaſs; a body, which I preſume you will not ſay was pre-exiſtent in it, but produced by the fire. To which I ſhall add but this one example more, namely, that by a certain artificial way of handling quick-ſilver, you may without addition ſeparate from it at leaſt a fifth, or fourth part of clear liquor; which, with an ordinary Peripatetick, would paſs for water, and which a vulgar chymiſt would not ſcruple to call phlegm, and which, for aught I have yet ſeen or heard, is not reducible into mercury again, and conſequently is more than a diſguiſe of it. Now, beſides that divers chymiſts will not allow mercury to have any, or at leaſt any conſiderable quantity of either of the ignoble ingredients, earth and water; beſides this, I ſay, the great ponderouſneſs of quick-ſilver makes it very unlikely, that it can have ſo much water in it, as may be thus obtained from it, ſince mercury weighs twelve or fourteen times as much as water of the ſame bulk. Nay, for a further confirmation of this argument, I will add this ſtrange relation, that two friends of mine, the one a phyſician, and the other a mathematician, and both of them perſons of unſuſpected credit, have ſolemnly aſſured me, that after many trials, they made to reduce mercury into water, in order to a philoſophical work, upon gold (which yet, by the way, I know proved unſucceſsful) they did once, by divers cohobations reduce a pound of quick-ſilver into almoſt a pound of water, and this, without the addition of any other ſubſtance, but only by preſſing the mercury by a ſkilfully managed fire, in purpoſely contrived veſſels. But of theſe experiments, our friend, (ſays *Carneades*, pointing at the Regiſter of this dialogue) will, perhaps, give you a more particular account, than it is neceſſary for me to do; ſince what I have now ſaid, may ſufficiently evince, that the fire may ſometimes as well alter bodies as divide them, and by it we may obtain from a mixed body, what was not pre-exiſtent in it. And how are we ſure, that in no other body, what we call phlegm is barely ſeparated, not produced ed by the action of the fire? ſince ſo many other mixed bodies are of a much leſs conſtant, and more alterable nature, than mercury (by many tricks it is wont to put upon chymiſts, and, by the experiments I told you of, about an hour ſince,) appears to be. But, becauſe I ſhall ere long have occaſion to reſume into conſideration the power of the fire to produce new concretes, I ſhall no longer inſiſt on this argument at preſent: only I muſt mind you, that if you will not diſbelieve *Helmont*'s relations, you muſt confeſs, that the *tria prima* are neither ingenerable, nor incorruptible ſubſtances; ſince by his alkaheſt ſome of them may be produced of bodies, that were before of another denomination; and by the ſame powerful menſtruum all of them may be reduced into inſipid water.

HERE *Carneades* was about to paſs on to his third conſideration, when *Eleutherius* being deſirous to hear what he could ſay, to clear his ſecond general conſideration from being repugnant to what he ſeemed to think the true theory of miſtion, prevented him, by telling him, I ſomewhat wonder, *Carneades*, that you,

who are in ſo many points unſatisfied with the Peripatetick opinion touching the elements and mixed bodies, ſhould alſo ſeem averſe to that notion touching the manner of miſtion, wherein the chymiſts (though perhaps without knowing, that they do ſo) agree with moſt of the antient philoſophers, that preceded *Ariſtotle*; and that for reaſons ſo conſiderable, that divers modern naturaliſts and phyſicians, in other things unfavourable enough to the Spagyriſts, do in this caſe ſide with them againſt the common opinion of the ſchools. If you ſhould aſk me (continues *Eleutherius*) what reaſons I mean? I ſhould partly by the writings of *Sennertus* and other learned men, and partly by my own thoughts, be ſupplied with more, than it were at preſent proper for me to inſiſt largely on. And therefore, I ſhall mention only, and that briefly, three or four. Of theſe, I ſhall take the firſt, from the ſtate of the controverſy it ſelf, and the genuine notion of miſtion, which, though much intricated by the ſchoolmen, I take in ſhort to be this: *Ariſtotle*, at leaſt, as many of his interpreters expound him, and as indeed he teaches in ſome places, where he profeſſedly diſſents from the ancients, declares miſtion to be ſuch a mutual penetration, and perfect union of the mingled elements, that there is no portion of the mixed body, how minute ſoever, which does not contain all, and every of the four elements, or in which, if you pleaſe, all the elements are not. And I remember, that he reprehends the miſtion taught by the ancients, as too ſlight or groſs, for this reaſon, that bodies mixed according to their hypotheſis, though they appear to human eyes, would not appear ſuch to the acute eyes of a lynx, whoſe perfecter ſight would diſcern the elements, if they were no otherwiſe mingled, than as his predeceſſors would have it, to be but blended, not united; whereas the ancients, though they did not all agree about what kind of bodies were mixed, yet they did almoſt unanimouſly hold, that in a compounded body, though the *Miſcibilia*, whether elements, principles, or whatever they pleaſed to call them, were aſſociated in ſuch ſmall parts, and with ſo much exactneſs, that there was no ſenſible part of the maſs, but ſeemed to be of the ſame nature with the reſt, and with the whole; yet as to the atoms, or other inſenſible parcels of matter, whereof each of the *Miſcibilia* conſiſted, they retained each of them its own nature, being but by appoſition or juxta-poſition united with the reſt into one body. So that although by virtue of this compoſition the mixed body did, perhaps, obtain divers new qualities; yet ſtill the ingredients, that compounded it, retaining their own nature, were by the deſtruction of the compoſitum ſeparable from each other, the minute parts diſingaged from thoſe of a differing nature, and aſſociated with thoſe of their own ſort, returning to be again, fire, earth, or water, as they were before they chanced to be ingredients of that compoſitum. This may be explained (continues *Eleutherius*,) by a piece of cloth made of white and black threads interwoven, wherein though the whole piece appear neither white nor black, but of a reſulting colour, that is grey, yet each of the white and black threads, that compoſe it, remains what it was before, as would appear, if the threads were pulled aſunder, and ſorted each colour by it ſelf. This (purſues *Eleutherius*) being, as I underſtand it, the ſtate of the controverſy, and the Ariſtotelians, after their maſter, commonly defining, that miſtion is *miſcibilium alteratorum unio*, that ſeems to comport much better with the opinion of the Chymiſts, than with that of their adverſaries; ſince, according to that, as the newly-mentioned example declares, there is but a juxta-poſition of ſeparable corpuſcles, retaining each its own nature; whereas, according to the Ariſtotelians, when what they are pleaſed to call a mixed body, reſults from the concourſe of the elements, the *Miſcibilia* cannot ſo properly be ſaid to be altered, as deſtroyed, ſince there is no part in the mixed body, how ſmall ſoever, that can be called either fire, or air, or water, or earth.

NOR, indeed, can I well underſtand, how bodies can be mingled other ways, than as I have declared, or, at leaſt, how they can be mingled, as our Peripateticks would have it. For whereas *Ariſtotle* tells us, that, if a drop of wine be put into ten thouſand meaſures of water, the wine being overpowered by ſo vaſt a quantity of water, will be turned into it, he ſpeaks, to my apprehenſion, very improbably. For, though one ſhould add to that quantity of water as many drops of wine, as would a thouſand times exceed it all, yet, by his rule, the whole liquor ſhould not be a *crama*, a mixture of wine and water, wherein the wine would be predominant, but water only; ſince the wine being added but by a drop at a time, would ſtill fall into nothing but water, and conſequently would be turned into it. And, if this would hold in metals too, it were a rare ſecret for goldſmiths, and refiners; for by melting a maſs of gold, or ſilver, and by but caſting into it lead or antimony, grain after grain, they might at pleaſure, within a reaſonable compaſs of time, turn what quantity they deſire, of the ignoble into the noble metals. And, indeed, ſince a pint of wine, and a pint of water, amount to about a quart of liquor, it ſeems manifeſt to ſenſe, that theſe bodies do not totally penetrate one another, as one would have it; but, that each retains its own dimenſions; and conſequently, that they are, by being mingled, only divided into minute bodies, that do but touch one another with their ſurfaces, as do the grains of wheat, rye, barley, *&c.* in a heap of ſeveral ſorts of corn. And unleſs we ſay, that as when one meaſure of wheat, for inſtance, is blended with a hundred meaſures of barley, there happens only a juxta-poſition and ſuperficial contact betwixt the grains of wheat, and as many or thereabouts of the grains of barley; ſo, when a drop of wine is mingled with a great deal of water, there is but an appoſition of ſo many vinous corpuſcles to a correſpondent number of aqueous ones: unleſs I ſay, this be ſaid, I ſee not how that abſurdity will be avoided, whereunto the Stoical notion of miſtion (name-

ly by σύγχυσις, or confuſion) was liable, according to which the leaſt body may be coextended with the greateſt: ſince in a mixt body, wherein, before the elements were mingled, there was, for inſtance, but one pound of water to ten thouſand of earth, yet according to them there muſt not be the leaſt part of that compound, that conſiſted not as well of earth, as water. But I inſiſt, perhaps, too long (ſays *Eleutherius*) upon the proofs afforded me by the nature of miſtion: wherefore I will but name two or three other arguments; whereof the firſt ſhall be, that, according to *Ariſtotle* himſelf, the motion of a mixt body follows the nature of the predominant element, as thoſe, wherein the earth prevails, tend towards the centre of heavy bodies. And ſince many things make it evident, that in divers mixt bodies the elementary qualities are as well active, though not altogether ſo much ſo, as in the elements themſelves; it ſeems not reaſonable to deny the actual exiſtence of the elements in thoſe bodies, wherein they operate.

To which I ſhall add this convincing argument, that experience manifeſts, and *Ariſtotle* confeſſes it, that the *Miſcibilia* may be again ſeparated from a mixt body, as is obvious in the chymical reſolutions of plants and animals, which could not be, unleſs they did actually retain their forms in it. For ſince, according to *Ariſtotle*, and I think according to truth, there is but one common maſs of all things, which he has been pleaſed to call *materia prima*; and ſince it is not therefore the matter, but the form, that conſtitutes and diſcriminates things, to ſay, that the elements remain not in a mixt body, according to their forms, but according to their matter, is not to ſay, that they remain there at all; ſince although thoſe portions of matter were earth and water, *&c.* before they concurred, yet the reſulting body being once conſtituted, may as well be ſaid to be ſimple as any of the elements; the matter being confeſſedly of the ſame nature in all bodies, and the elementary forms being, according to this hypotheſis, periſhed and aboliſhed.

AND laſtly, and if we will conſult chymical experiments, we ſhall find the advantages of the chymical doctrine above the Peripatetick title little leſs than palpable. For in that operation, that refiners call quartation, which they employ to purify gold, although three parts of ſilver be ſo exquiſitely mingled by fuſion with a fourth part of gold (whence the operation is denominated) that the reſulting maſs acquires ſeveral new qualities, by virtue of the compoſition, and that there is ſcarce any ſenſible part of it, that is not compoſed of both the metals; yet if you caſt this mixture into aqua fortis, the ſilver will be diſſolved in the menſtruum, and the gold like a dark or black powder will fall to the bottom of it, and either body may be again reduced into ſuch a metal as it was before; which ſhews, that it retained its nature, notwithſtanding its being mixt *per minima* with the other. We likewiſe ſee, that though one part of pure ſilver be mingled with eight or ten parts, or more, of lead; yet the fire will upon the cupel eaſily and perfectly ſeparate them again. And that, which I would have you peculiarly conſider on this occaſion, is, that not only in chymical anatomies there is a ſeparation made of the elementary ingredients, but that ſome mixt bodies afford a very much greater quantity of this or that element or principle, than of another; as we ſee, that turpentine and amber yield much more oil and ſulphur, than they do water; whereas wine, which is confeſſed to be a perfectly mixt body, yields but a little inflammable ſpirit, or ſulphur, and not much more earth; but affords a vaſt proportion of phlegm or water. Which could not be, if, as the Peripateticks ſuppoſe, every, even of the minuteſt particles, were of the ſame nature with the whole, and conſequently did contain both earth and water, and air, and fire. Wherefore as to what *Ariſtotle* principally, and almoſt only objects, that unleſs his opinion be admitted, there would be no true and perfect miſtion, but only aggregates or heaps of contiguous corpuſcles, which, though the eye of a man cannot diſcern, yet the eye of a lynx might perceive not to be of the ſame nature with one another and with their totum, as the nature of miſtion requires, if he do not beg the queſtion, and make miſtion to conſiſt in what other naturaliſts deny to be requiſite to it, yet he, at leaſt, objects that as a great inconvenience, which I cannot take for ſuch, till he have brought as conſiderable arguments as I have propoſed to prove the contrary, to evince, that nature makes other miſtions than ſuch as I have allowed, wherein the *Miſcibilia* are reduced into minute parts, and united as far as ſenſe can diſcern: which if you will not grant to be ſufficient for a true miſtion, he muſt have the ſame quarrel with nature her ſelf, as with his adverſaries.

WHEREFORE (continues *Eleutherius*) I cannot but ſomewhat marvel, that *Carneades* ſhould oppoſe the doctrine of the chymiſts in a particular, wherein they do as well agree with his old miſtreſs, Nature, as diſſent from his old adverſary, *Ariſtotle*.

I MUST not (replies *Carneades*) engage my ſelf at preſent to examine throughly the controverſies concerning miſtion: and if there were no third thing, but that I were reduced to embrace abſolutely and unreſervedly either the opinion of *Ariſtotle*, or that of the philoſophers, that went before him, I ſhould look upon the latter, which the chymiſts have adopted, as the more defenſible opinion. But becauſe differing in the opinions about the elements from both parties, I think I can take a middle courſe, and diſcourſe to you of miſtion, after a way, that does neither perfectly agree, nor perfectly diſagree with either: as I will not peremptorily define, whether there be not caſes, wherein ſome phænomena of miſtion ſeem to favour the opinion, that the chymiſts patrons borrowed of the ancients, I ſhall only endeavour to ſhew you, that there are ſome caſes, which may keep the doubt, which makes up my ſecond general conſideration, from being unreaſonable.

I SHALL then freely acknowledge to you, (ſays *Carneades*) that I am not over-well ſatisfied

fied with the doctrine, that is aſcribed to *Ariſtotle*, concerning miſtion; eſpecially, ſince it teaches, that the four elements may again be ſeparated from the mixt body; whereas, if they continued not in it, it would not be ſo much a ſeparation as a production. And I think the ancient philoſophers, that preceded *Ariſtotle*, and chymiſts, who have ſince received the ſame opinion, do ſpeak of this matter more intelligibly, if not more probably, than the Peripateticks: but though they ſpeak congruouſly enough to their believing, that there are a certain number of primogenial bodies, by whoſe concourſe all thoſe we call mixt are generated, and which, in the deſtruction of mixt bodies, do barely part company, and reduce from one another, juſt ſuch as they were when they came together; yet I, who meet with very few opinions, that I can entirely acquieſce in, muſt confeſs to you, that I am inclined to differ, not only from the Ariſtotelians, but from the old philoſophers and the chymiſts, about the nature of miſtion. And if you will give me leave, I ſhall briefly propoſe to you my preſent notion of it, provided you will look upon it, not ſo much as an aſſertion as an hypotheſis; in talking of which, I do not now pretend to propoſe and debate the whole doctrine of miſtion, but to ſhew, that it is not improbable, that ſometimes mingled ſubſtances may be ſo ſtrictly united, that it doth not by the uſual operations of the fire, by which chymiſts are wont to ſuppoſe themſelves to have made the analyſis of mixt bodies, ſufficiently appear, that in ſuch bodies the *Miſcibilia*, that concurred to make them up, do each of them retain its own peculiar nature; and by the Spagyriſts fires may be more eaſily extricated and recovered, than altered; either by a change of texture in the parts of the ſame ingredient, or by an aſſociation with ſome parts of another ingredient, more ſtrict than was that of the parts of this or that *Miſcibile* among themſelves. At theſe words, *Eleutherius* having preſſed him to do what he propoſed, and promiſed to do what he deſired;

I CONSIDER then (reſumes *Carneades*) that, not to mention thoſe improper kinds of miſtion, wherein homogeneous bodies are joined, as when water is mingled with water, or two veſſels full of the ſame kind of wine with one another, the miſtion I am now to diſcourſe of ſeems, generally ſpeaking, to be but an union *per minima* of any two or more bodies of differing denominations; as when aſhes and ſand are colliquated into glaſs, or antimony and iron into regulus martis, or wine and water are mingled, and ſugar is diſſolved in the mixture. Now in this general notion of miſtion it does not appear clearly comprehended, that the *Miſcibilia* or ingredients do in their ſmall parts ſo retain their nature, and remain diſtinct in the compound, that they may thence by the fire be again taken aſunder: for though I deny not, that in ſome miſtions of certain permanent bodies this recovery of the ſame ingredients may be made, yet I am not convinced, that it will hold in all, or even in moſt, or that it is neceſſarily deducible from chymical experiments, and the true notion of miſtion. To explain this a little, I aſſume, that bodies may be mingled, and that very durably, that are not elementary, nor have been reſolved into elements or principles, that they may be mingled; as is evident in the regulus of colliquated antimony, and iron newly mentioned; and in gold coin, which laſts ſo many ages; wherein generally the gold is alloyed by the mixture of a quantity, greater or leſſer, (in our mints they uſe about a 12th part) of either ſilver, or copper, or both. Next, I conſider, that there being but one univerſal matter of things, as it is known that the Ariſtotelians themſelves acknowledge, who call it *materia prima*, (about which nevertheleſs I like not all their opinions) the portions of this matter ſeem to differ from one another but in certain qualities or accidents, fewer or more; upon whoſe account the corporeal ſubſtance they belong to receives its denomination, and is referred to this or that particular ſort of bodies: ſo that if it come to loſe, or be deprived of thoſe qualities, though it ceaſes not to be a body, yet it ceaſes from being that kind of body as a plant, or animal, or red, green, ſweet, ſour, or the like. I conſider, that it very often happens, that the ſmall parts of bodies cohere together but by immediate contact and reſt, and that, however, there are few bodies, whoſe minute parts ſtick ſo cloſe together, to what cauſe ſoever their combination be aſcribed, but that it is poſſible to meet with ſome other body, whoſe ſmall parts may get between them, and ſo diſjoin them; or may be fitted to cohere more ſtrongly with ſome of them, than thoſe ſome do with the reſt; or at leaſt may be combined ſo cloſely with them, as that neither the fire, nor the other uſual inſtruments of chymical anatomies will ſeparate them. Theſe things being premiſed, I will not peremptorily deny, but that there may be ſome cluſters of particles, wherein the particles are ſo minute, and the coherence ſo ſtrict, or both, that when bodies of differing denominations, and conſiſting of ſuch durable cluſters, happen to be mingled, though the compound body made up of them may be very differing from either of the ingredients, yet each of the little maſſes or cluſters may ſo retain its own nature, as to be again ſeparable, ſuch as it was before. As when gold and ſilver being melted together in a due prodortion (for in every proportion, the refiners will tell you, that the experiment will not ſucceed) aqua fortis will diſſolve the ſilver, and leave the gold untouched; by which means, as you lately noted, both the metals may be recovered from the mixed maſs. But (continues *Carneades*) there are other cluſters, wherein the particles ſtick not ſo cloſe together, but that they may meet with corpuſcles of another denomination, which are diſpoſed to be more cloſely united with ſome of them, than they were among themſelves. And in ſuch caſe, two thus combining corpuſcles loſing that ſhape, or ſize, or motion, or other accident, upon whoſe account they were endowed with ſuch a determinate quality or nature, each of them really ceaſes to be a corpuſcle of the ſame denomination

denomination it was before; and from the coalition of theſe there may emerge a new body, as really one, as either of the corpuſcles was before they were mingled, or, if you pleaſe, confounded: ſince this concretion is really endowed with its own diſtinct qualities, and can no more by the fire, or any other known way of analyſis, be divided again into the corpuſcles, that at firſt concurred to make it, than either of them could, by the ſame means, be ſubdivided into other particles. But (ſays *Eleutherius*) to make this more intelligble by particular examples; if you diſſolve copper in aqua fortis, or ſpirit of nitre, (for I remember not which I uſed, nor do I think it much material) you may by cryſtallizing the ſolution obtain a goodly vitriol; which, though by virtue of the compoſition it have manifeſtly divers qualities, not to be met with in either of the ingredients, yet it ſeems, that the nitrous ſpirits, or at leaſt many of them, may in this compounded maſs retain their former nature: for having for trial-ſake diſtilled this vitriol ſpirit, there came over ſtore of red fumes, which by that colour, by their peculiar ſtink, and by their ſourneſs, manifeſted themſelves to be nitrous ſpirits, and that the remaining calx continued copper, I ſuppoſe you will eaſily believe. But if you diſſolve minium, which is but lead powdered by the fire, in good ſpirit of vinegar, and cryſtallize the ſolution, you ſhall not only have a ſaccharine ſalt exceedingly differing from both its ingredients; but the union of ſome parts of the menſtruum with ſome of thoſe of the metal is ſo ſtrict, that the ſpirit of vinegar ſeems to be, as ſuch, deſtroyed; ſince the ſaline corpuſcles have quite loſt that acidity, upon whoſe account the liquor was called ſpirit of vinegar; nor can any ſuch acid parts, as were put to the minium, be ſeparated by any known way from the *ſaccharum Saturni* reſulting from them both. For not only there is no ſourneſs at all, but an admirable ſweetneſs to be taſted in the concretion; and not only I found not that ſpirit of wine, which otherwiſe will immediately hiſs, when mingled with ſtrong ſpirit of vinegar, would hiſs being poured upon *ſaccharum Saturni*, wherein yet the acid ſalt of vinegar, did it ſurvive, may ſeem to be concentrated; but upon the diſtillation of *ſaccharum Saturni* by it ſelf, I found indeed a liquor very penetrant, but not at all acid, and differing as well in ſmell and other qualities, as in taſte, from the ſpirit of vinegar; which likewiſe ſeemed to have left ſome of its parts very firmly united to the *caput mortuum*, which though of a leaden nature was in ſmell, colour, *&c.* differing from minium. Which brings into my mind, that though two powders, the one blue, and the other yellow, may appear a green mixture, without either of them loſing its own colour, as a good microſcope has ſometimes informed me; yet having mingled minium and ſal armoniac in a requiſite proportion, and expoſed them in a glaſs veſſel to the fire, the whole maſs became white, and the red corpuſcles were deſtroyed: for though the calcined lead was ſeparable from the ſalt, yet you will eaſily believe it did not part from it in the form of a red powder, ſuch as was the minium, when it was put to the ſal armoniac. I leave it alſo to be conſidered, whether in blood, and divers other bodies, it be probable, that each of the corpuſcles, that concur to make a compound body, doth, though ſome of them in ſome caſes may, retain its own nature in it, ſo that chymiſts may extricate each ſort of them from all the others, wherewith it concurred to make a body of one denomination.

I KNOW there may be a diſtinction betwixt matter immanent, when the material parts remain, and retain their own nature in the things materiated, as ſome of the ſchoolmen ſpeak, (in which ſenſe, wood, ſtones and lime are the matter of a houſe;) and tranſient, which in the materiated thing is ſo altered, as to receive a new form, without being capable of re-admitting again the old. In which ſenſe the friends of this diſtinction ſay, that chyle is the matter of blood, and blood that of a human body, of all whoſe parts it is preſumed to be the aliment. I know alſo, that it may be ſaid, that of material principles, ſome are common to all mixt bodies, as *Ariſtotle*'s four elements, or the chymiſts *tria prima*; others peculiar, which belong to this or that ſort of bodies; as butter and a kind of whey may be ſaid to be the proper principles of cream: and I deny not, but that theſe diſtinctions may in ſome caſes be of uſe; but partly by what I have ſaid already, and partly by what I am to ſay, you may eaſily enough gueſs, in what ſenſe I admit them, and diſcern, that in ſuch a ſenſe they will either illuſtrate ſome of my opinions, or at leaſt will not overthrow any of them.

TO proſecute then what I was ſaying before, I will add to this purpoſe, that ſince the major part of chymiſts credit what thoſe they call philoſophers affirm of their ſtone, I may repreſent to them, that though when common gold and lead are mingled together, the lead may be ſever'd almoſt unaltered from the gold; yet if inſtead of gold a tantillum of the red elixir be mingled with the ſaturn, their union will be ſo indiſſoluble in the perfect gold, that will be produced by it, that there is no known, nor perhaps no poſſible way of ſeparating the diffuſed elixir from the fixed lead, but they both conſtitute a moſt permanent body, wherein the ſaturn ſeems to have quite loſt its properties, that made it be called lead, and to have been rather tranſmuted by the elixir, than barely aſſociated to it. So that it ſeems not always neceſſary, that the bodies, that are put together *per minima*, ſhould each retain its own nature; ſo as when the maſs it ſelf is diſſipated by the fire, to be more diſpoſed to re-appear in its priſtine form, than in any new one, which by a ſtricter aſſociation of its parts with thoſe of ſome of the other ingredients of the compoſitum, than with one another, it may have acquired.

AND if it be objected, that unleſs the hypotheſis I oppoſe be admitted, in ſuch caſes as I have propoſed, there would not be an union, but a deſtruction of mingled bodies, which ſeems all one as to ſay, that of ſuch bodies there is no miſtion at all; I anſwer, that though the ſubſtances, that are mingled, remain, only

their accidents are deſtroyed, and though we may with tolerable congruity call them *Miſcibilia*, becauſe they are diſtinct bodies before they are put together, however afterwards they are ſo confounded, that I ſhould rather call them concretions, or reſulting bodies, than mixed ones; and though, perhaps, ſome other and better account may be propoſed, upon which the name of miſtion may remain; yet, if what I have ſaid be thought reaſon, I ſhall not wrangle about words, though I think it fitter to alter a term of art, than reject a new truth, becauſe it ſuits not with it. If it be alſo objected, that this notion of mine, concerning miſtion, though it may be allowed, when bodies already compounded are put to be mingled, yet it is not applicable to thoſe miſtions, that are immediately made of the elements, or principles themſelves; I anſwer in the firſt place, that I here conſider the nature of miſtion ſomewhat more generally, than the chymiſts; who yet cannot deny, that there are oftentimes mixtures, and thoſe very durable ones, made of bodies, that are not elementary. And in the next place, that though it may be probably pretended, that in thoſe mixtures, that are made immediately of the bodies, that are called principles or elements, the mingled ingredients may better retain their own nature in the compounded maſs, and be more eaſily ſeparated from thence; yet, beſides that it may be doubted, whether there be any ſuch primary bodies, I ſee not why the reaſon I alledged, of the deſtructibility of the ingredients of bodies in general, may not ſometimes be applicable to ſalt, ſulphur, or mercury; till it be ſhewn upon what account we are to believe them privileged. And however, (if you pleaſe but to recall to mind, to what purpoſe I told you at firſt, I meant to ſpeak of miſtion at this time) you will perhaps allow, that what I have hitherto diſcourſed about it, may not only give ſome light to the nature of it in general, (eſpecially when I ſhall have an opportunity to declare to you my thoughts on that ſubject more fully) but may on ſome occaſions alſo be ſerviceable to me in the enſuing part of this diſcourſe.

BUT to look back now to that part of our diſcourſe, whence this excurſion concerning miſtion has ſo long diverted us, though we there deduced, from the differing ſubſtances obtained from a plant nouriſhed only with water, and from ſome other things, that it was not neceſſary, that nature ſhould always compound a body at firſt of all ſuch differing bodies, as the fire could afterwards make it afford; yet this is not all, that may be collected from thoſe experiments. For from them there ſeems alſo deducible ſomething, that ſubverts another foundation of the chymical doctrine. For ſince that (as we have ſeen) out of fair water alone, not only ſpirit, but oil, and ſalt, and earth may be produced; it will follow, that ſalt and ſulphur are not primogenial bodies, and principles, ſince they are every day made out of plain water by the texture, which the ſeed or ſeminal principle of plants put it into. And this would not perhaps ſeem ſo ſtrange, if, through pride or negligence, we were not wont to overlook the obvious and familiar workings of nature; for if we conſider what ſlight qualities they are, that ſerve to denominate one of the *tria prima*, we ſhall find, that nature does frequently enough work as great alterations in divers parcels of matter: for to be readily diſſoluble in water, is enough to make the body, that is ſo, paſs for a ſalt. And yet I ſee not, why from a new ſhuffling and diſpoſition of the component particles of a body, it ſhould be much harder for nature to compoſe a body diſſoluble in water, of a portion of water, that was not ſo before, than of the liquid ſubſtance of an egg, which will eaſily mix with water, to produce by the bare warmth of a hatching hen, membranes, feathers, tendons, and other parts, that are not diſſoluble in water as that liquid ſubſtance was: nor is the hardneſs and brittleneſs of ſalt more difficult for nature to introduce into ſuch a yielding body as water, than it is for her to make the bones of a chick out of the tender ſubſtance of the liquors of an egg. But inſtead of proſecuting this conſideration, as I eaſily might, I will proceed as ſoon as I have taken notice of an objection, that lies in my way. For I eaſily foreſee it will be alledged, that the above mentioned examples are all taken from plants, and animals, in whom the matter is faſhioned by the plaſtick power of the ſeed, or ſomething analogus thereunto. Whereas the fire does not act like any of the ſeminal principles, but deſtroys them all, when they come within its reach. But to this I ſhall need at preſent to make but this eaſy anſwer, that whether it be a ſeminal principle, or any other, which faſhions that matter after thoſe various manners I have mentioned to you, yet it is evident, that either by the plaſtick principle alone, or that and heat together, or by ſome other cauſe capable to contex the matter, it is yet poſſible, that the matter may be anew contrived into ſuch bodies. And it is only for the poſſibility of this, that I am now contending.

THE SCEPTICAL CHYMIST:

PART III.

WHAT I have hitherto diſcourſed, *Eleutherius*, (ſays his friend to him) has, I preſume, ſhewn you, that a conſidering man may very well queſtion the truth of thoſe very ſuppoſitions, which Chymiſts as well as Peripateticks, without proving, take for granted; and upon which depends the validity of the inferences they draw from their experiments. Wherefore having diſpatched that, which though a chymiſt perhaps will not, yet I do, look upon as the moſt important, as well as difficult, part of my taſk, it will now be ſeaſonable for me to proceed to the conſideration of the experiments themſelves, wherein they are wont ſo much to triumph and glory. And theſe will the rather deſerve a ſerious examination, becauſe thoſe, that alledge them, are wont to do it with ſo much confidence and oſtentation, that they have hitherto impoſed upon almoſt all perſons, without excepting philoſophers and phyſicians themſelves, who have read their books, or heard them talk. For ſome learned men have been content rather to believe what they ſo boldly affirm, than be at the trouble and charge, to try whether or no it be true. Others again, who have curioſity enough to examine the truth of what is averred, want ſkill and opportunity to do what they deſire. And the generality even of learned men, ſeeing the chymiſts (not contenting themſelves with the ſchools to amuſe the world with empty words) actually perform divers ſtrange things, and, among thoſe, reſolve compound bodies into ſeveral ſubſtances, not known by former philoſophers to be contained in them; men I ſay, ſeeing theſe things, and hearing with what confidence chymiſts aver the ſubſtances obtained from compound bodies by the fire to be the true elements, or, (as they ſpeak) hypoſtatical principles of them, are forward to think it but juſt, as well as modeſt, that according to the logicians rule, the ſkilful artiſts ſhould be credited in their own art; eſpecially when thoſe things, whoſe nature they ſo confidently take upon them to teach others, are not only productions of their own ſkill, but ſuch as others know not elſe what to make of.

BUT though (continues *Carneades*) the chymiſts have been able upon ſome or other of the mentioned accounts, not only to delight but amaze, and almoſt to bewitch even learned men; yet ſuch as you and I, who are not unpractiſed in the trade, muſt not ſuffer our ſelves to be impoſed upon by hard names, or bold aſſertions; nor to be dazled by that light which ſhould but aſſiſt us to diſcern things the more clearly. It is one thing to be able to help nature to produce things, and another thing to underſtand well the nature of the things produced. As we ſee, that many perſons, that can beget children, are for all that as ignorant of the number and nature of the parts, eſpecially the internal ones, that conſtitute a child's body, as they that never were parents. Nor do I doubt, but you will excuſe me, if, as I thank the chymiſts for the things their analyſis ſhews me, ſo I take the liberty to conſider, how many, and what they are, without being aſtoniſhed at them; as if, whoſoever hath ſkill enough to ſhew men ſome new thing of his own making, had the right to make them believe whatſoever he pleaſes to tell them concerning it.

WHEREFORE, I will now proceed to my third general conſideration; which is, that it does not appear, that three is preciſely and univerſally the number of the diſtinct ſubſtances or elements, whereinto mixt bodies are reſoluble by the fire: I mean, that it is not proved by chymiſts, that all the compound bodies, which are granted to be perfectly mixt, are upon their chymical analyſis diviſible each of them into juſt three diſtinct ſubſtances, neither more nor leſs, which are wont to be looked upon as elementary, or may as well be reputed ſo as thoſe, that are ſo reputed. Which laſt clauſe I ſubjoin, to prevent your objecting, that ſome of the ſubſtances I may have occaſion to mention by and by, are not perfectly homogeneous, nor conſequently worthy of the name of principles. For that which I am now to conſider is, into how many differing ſubſtances, that may plauſibly paſs for the elementary ingredients of a mixt body, it may be analyzed by the fire; but whether each of theſe be uncompounded I reſerve to examine, when I ſhall come to the next general conſideration; where I hope to evince, that the ſubſtances, which the chymiſts not only allow, but aſſert to be the component principles of the body reſolved into them, are not wont to be uncompounded.

Now there are two kind of arguments (purſues *Carneades*) which may be brought to make my third propoſition ſeem probable; one ſort of them being of a more ſpeculative nature, and the other drawn from experience. To begin then with the firſt of theſe.

BUT as *Carneades* was going to do as he had ſaid, *Eleutherius* interrupted him, by ſaying with a ſomewhat ſmiling countenance;

IF you have no mind I ſhould think, that the proverb, *that good wits have bad memories*, is rational and applicable to you, you muſt not forget now you are upon the ſpeculative conſiderations, that may relate to the number of the elements, that yourſelf did not long ſince deliver and concede ſome propoſitions in favour of the chymical doctrine, which I may without diſparagement to you think it uneaſy, even for *Carneades* to anſwer.

I HAVE not, replies he, forgot the conceſſions you mean; but I hope too, that you have not forgot neither with what cautions they were made, when I had not yet aſſumed the perſon I am now ſuſtaining. But however, I ſhall, to content you, ſo diſcourſe of my third general conſideration, as to let you ſee, that I am not unmindful of the things you would have me remember.

To talk then again according to ſuch principles as I then made uſe of, I ſhall repreſent, that if it be granted rational to ſuppoſe, as I then did, that the elements conſiſted at firſt of certain ſmall and primary coalitions of the minute particles of matter into corpuſcles very numerous, and very like each other, it will not be abſurd to conceive, that ſuch primary cluſters may be of far more ſorts than three or five; and conſequently, that we need not ſuppoſe, that in each of the compound bodies we are treating of, there ſhould be found juſt three ſorts of ſuch primitive coalitions, as we are ſpeaking of.

AND if, according to this notion, we allow a conſiderable number of differing elements, I may add, that it ſeems very poſſible, that to the conſtitution of one ſort of mixt bodies two kinds of elementary ones may ſuffice (as I lately exemplified to you, in that moſt durable concrete, glaſs,) another ſort of mixts may be compoſed of three elements, another of four, another of five, and another perhaps of many more. So that, according to this notion, there can be no determinate number aſſigned, as that of the elements of all ſorts of compound bodies whatſoever; it being very probable, that ſome concretes conſiſt of fewer, ſome of more elements. Nay, it does not ſeem impoſſible, according to theſe principles, but that there may be two ſorts of mixts, whereof the one may not have any of all the ſame elements as the other conſiſts of; as we oftentimes ſee two words, whereof the one has not any one of the letters to be met with in the other; or as we often meet with divers electuaries, in which no ingredient (except ſugar) is common to any two of them. I will not here debate, whether there may not be a multitude of theſe corpuſcles, which by reaſon of their being primary and ſimple, might be called elementary, if ſeveral ſorts of them ſhould convene to compoſe any body, which are as yet free, and neither as yet contexed and entangled with primary corpuſcles of other kinds, but remain liable to be ſubdued and faſhioned by ſeminal principles, or the like powerful and tranſmuting agent; by whom they may be ſo connected among themſelves, or with the parts of the bodies, as to make the compound bodies, whoſe ingredients they are, reſoluble into more, or other elements than thoſe that chymiſts have hitherto taken notice of.

To all which I may add, that ſince it appears, by what I obſerved to you of the permanency of gold and ſilver, that even corpuſcles, that are not of an elementary, but compounded nature, may be of ſo durable a texture, as to remain indiſſoluble in the ordinary analyſis that Chymiſts make of bodies by the fire; it is not impoſſible, but that, though there were but three elements, yet there may be a greater number of bodies, which the wonted ways of anatomy will not diſcover to be no elementary bodies.

BUT, (ſays *Carneades*) having thus far, in compliance to you, talked conjecturally of the number of the elements, it is now time to conſider, not of how many elements it is poſſible that nature may compound mixed bodies, but (at leaſt, as far as the ordinary experiments of chymiſts will inform us) of how many ſhe doth make them up.

I SAY then, that it does not by theſe ſufficiently appear to me, that there is any one determinate number of elements to be uniformly met with in all the ſeveral ſorts of bodies allowed to be perfectly mixed.

AND for the more diſtinct proof of this propoſition, I ſhall in the firſt place repreſent, that there are divers bodies, which I could never ſee by fire divided into ſo many as three elementary ſubſtances. I would fain (as I ſaid lately to *Philoponus*) ſee that fixed and noble metal we call gold, ſeparated into ſalt, ſulphur and mercury: and if any man will ſubmit to a competent forfeiture in caſe of failing, I ſhall willingly, in caſe of proſperous ſucceſs, pay for both the materials and the charges of ſuch an experiment. It is not, that after what I have tried my ſelf I dare peremptorily deny, that there may out of gold be extracted a certain ſubſtance, which I cannot hinder chymiſts from calling its tincture or ſulphur; and which leaves the remaining body deprived of its wonted colour. Nor am I ſure, that there cannot be drawn out of the ſame metal a real quick and running mercury. But for the ſalt of gold, I never could either ſee it, or be ſatisfied that there was ever ſuch a thing ſeparated, *in rerum naturâ*, by the relation of any credible eye-witneſs. And for the ſeveral proceſſes, that promiſe that effect, the materials, that muſt be wrought upon, are ſomewhat too precious and coſtly to be waſted upon ſo groundleſs adventures, of which not only the ſucceſs is doubtful, but the very poſſibility is not yet demonſtrated. Yet that, which moſt deters me from ſuch trials, is not their chargeableneſs, but their unſatisfactorineſs, though they ſhould ſucceed. For the extraction of this golden ſalt being in chymiſts proceſſes preſcribed to be effected by corroſive menſtruums, or the intervention of other ſaline bodies, it will remain doubtful to a wary perſon, whether the emergent ſalt be that of the gold itſelf, or of the ſaline bodies or ſpirits employed to prepare it; for that ſuch diſguiſes of metals do often impoſe upon artiſts, I am ſure *Eleutherius* is not ſo much a ſtranger to chymiſtry as to ignore. I would likewiſe willingly ſee the three principles ſeparated from the pure ſort of virgin-ſand, from oſteocolla, from refined ſilver, from quickſilver freed from its adventitious ſulphur, from Venetian talc, which by long detention in an extreme reverberium, I could but divide into ſmaller particles, not the conſtituent principles; nay, which, when I cauſed it to be kept I know not how long, in a glaſs-houſe fire, came out in the figure its lumps had, when put in, though

though altered to an almoſt amethyſtine colour; and from divers other bodies, which it were now unneceſſary to enumerate. For though I dare not abſolutely affirm it to be impoſſible to analyze theſe bodies into their *tria prima*; yet becauſe neither my own experiments, nor any competent teſtimony hath hitherto either taught me, how ſuch an analyſis may be made, or ſatisfied me, that it hath been ſo; I muſt take the liberty to refrain from believing it, till the chymiſts prove it, or give us intelligible and practicable proceſſes to perform what they pretend. For whilſt they affect that enigmatical obſcurity, with which they are wont to puzzle the readers of their divulged proceſſes concerning the analytical preparation of gold or mercury, they leave wary perſons much unſatisfied, whether or no the differing ſubſtances, they promiſe to produce, be truly the hypoſtatical principles, or only ſome intermixtures of the divided bodies with thoſe employed to work upon them, as is evident in the ſeeming cryſtals of ſilver, and thoſe of mercury; which, though by ſome inconſiderately ſuppoſed to be the ſalts of thoſe metals, are plainly but mixtures of the metalline bodies with the ſaline parts of aqua fortis, or other corroſive liquors; as is evident by their being reducible into ſilver or quickſilver, as they were before.

I CANNOT but confeſs (ſaith *Eleutherius*) that though chymiſts may, upon probable grounds, affirm themſelves able to obtain their *tria prima* from animals and vegetables, yet I have often wondered, that they ſhould ſo confidently pretend alſo, to reſolve all metalline and other mineral bodies into ſalt, ſulphur, and mercury. For it is a ſaying almoſt proverbial among thoſe chymiſts themſelves, that are accounted philoſophers, and our famous countryman *Roger Bacon* has particularly adopted it; that *facilius eſt aurum facere, quam deſtruere*. And I fear, with you, that gold is not the only mineral, from which chymiſts are wont fruitleſly to attempt the ſeparating of their three principles. I know indeed (continues *Eleutherius*) that the learned *Sennertus*, even in that book, where he takes not upon him to play the advocate for the chymiſts, but the umpire betwixt them and the Peripateticks, expreſſes himſelf roundly, thus; *Salem omnibus ineſſe (mixtis ſcilicet) & ex iis fieri poſſe omnibus in reſolutionibus chymicis verſatis notiſſimum eſt.* And in the next page, *quod de ſale dixi*, ſays he, *idem de ſulphure dici poteſt.* But, by his favour, I muſt ſee very good proofs, before I believe ſuch general aſſertions, how boldly ſoever made; and he, that would convince me of their truth, muſt firſt teach me ſome true and practicable way of ſeparating ſalt and ſulphur from gold, ſilver, and thoſe many different ſorts of ſtones, that a violent fire does not bring to lime, but to fuſion: and not only I, for my own part, never ſaw any of thoſe newly named bodies ſo reſolved; but *Helmont*, who was much better verſed in the chymical anatomizing of bodies than either *Sennertus* or I, has ſomewhere this reſolute paſſage; *Scio* (ſays he) *ex arena, ſilicibus & ſaxis, non calcariis, nunquam ſulphur aut mercurium trahi poſſe:* nay, *Quercetanus* himſelf, though the grand ſtickler for the *tria prima*, has this confeſſion of the irreſolubleneſs of diamonds; *Adamas* (ſaith he) *omnium factus lapidum ſolidiſſimus ac duriſſimus ex artiſſima videlicet trium principiorum unione ac cohærentia, quæ nulla arte ſeparationis in ſolutionem principiorum ſuorum ſpiritualium disjungi poteſt.* And indeed, purſues *Eleutherius*, I was not only glad, but ſomewhat ſurprized to find you inclined to admit, that there may be a ſulphur and a running mercury drawn from gold; for unleſs you do (as your expreſſion ſeemed to intimate) take the word ſulphur in a very looſe ſenſe, I muſt doubt, whether our chymiſts can ſeparate a ſulphur from gold: for when I ſaw you make the experiment, that I ſuppoſe invited you to ſpeak as you did, I did not judge the golden tincture to be the true principle of ſulphur extracted from the body, but an aggregate of ſome ſuch highly coloured parts of the gold, as a chymiſt would have called a ſulphur incombuſtible, which in plain Engliſh ſeems to be little better than to call it a ſulphur and no ſulphur. And as for metalline mercuries, I had not wondered at it, though you had expreſſed much more ſeverity in ſpeaking of them; for I remember, that having once met an old and famous artiſt, who had long been (and ſtill is) chymiſt to a great monarch, the repute he had of a very honeſt man invited me to deſire him to tell me ingenuouſly, whether or no, among his many labours, he had ever really extracted a true and running mercury out of metals; to which queſtion he freely replied, that he had never ſeparated a true mercury from any metal; nor had ever ſeen it really done by any man elſe. And though gold is, of all metals, that, whoſe mercury chymiſts have moſt endeavoured to extract, and which they do the moſt brag they have extracted; yet the experienced *Angelus Sala*, in his ſpagyrical account of the ſeven terreſtrial planets (that is, the ſeven metals) affords us this memorable teſtimony, to our preſent purpoſe: *Quanquam* (ſays he) *&c. experientia tamen (quam ſtultorum magiſtram vocamus) certe comprobavit, mercurium auri adeo fixum, maturum, & arctè cum reliquis ejuſdem corporis ſubſtantiis conjungi, ut nullo modo retrogredi poſſit.* To which he ſubjoins, that he himſelf had ſeen much labour ſpent upon that deſign, but could never ſee any ſuch mercury produced thereby. And I eaſily believe what he annexes; *that he had often ſeen detected many tricks and impoſtures of cheating alchymiſts.* For, the moſt part of thoſe, that are fond of ſuch charletans, being unſkilful or credulous, or both, it is very eaſy for ſuch as have ſome ſkill, much craft, more boldneſs, and no conſcience, to impoſe upon them: and therefore, though many profeſſed alchymiſts, and divers perſons of quality have told me, that they have made or ſeen the mercury of gold, or of this or that other metal; yet I have been ſtill apt to fear, that either theſe perſons have had a deſign to deceive others, or have had not ſkill and circumſpection enough to keep themſelves from being deceived.

Quercet. apud Blich. in Theſſalo redivivo, pag. 99

Sennert. lib. de conſ. & diſſenſ. pag. 147.

Helmon. pag. 409.

You recall to my mind (ſays *Carneades*) a certain experiment I once deviſed, innocently to deceive ſome perſons, and let them and others ſee, how little is to be built upon the affirmation of thoſe, that are either unſkilful or unwary, when they tell us they have ſeen alchymiſts make the mercury of this or that metal: and to make this the more evident, I made my experiment much more ſlight, ſhort and ſimple, than the chymiſts uſual proceſſes to extract metalline mercuries; which operations being commonly more elaborate and intricate, and requiring a much more longer time, give the alchymiſts a greater opportunity to cozen, and conſequently are more obnoxious to the ſpectators ſuſpicion. And that, wherein I endeavoured to make my experiment look the more like a true analyſis, was, that I not only pretended, as well as others, to extract a mercury from the metal I wrought upon, but likewiſe to ſeparate a large proportion of manifeſt and inflammable ſulphur. I take then of the filings of copper about a dram or two; of common ſublimate, powdered, the like weight; and ſal armoniac near about as much as of ſublimate: theſe three being well mingled together, I put into a ſmall phial with a long neck, or, which I find better, into a glaſs-urinal, which (having firſt ſtopped it with cotton) to avoid the noxious fumes, I approach by degrees to a competent fire of well kindled coals, or (which looks better, but more endangers the glaſs) to the flame of a candle; and after a while the bottom of the glaſs being held juſt upon the kindled coals, or in the flame, you may in about a quarter of an hour, or, perchance, in half that time, perceive in the bottom of the glaſs ſome running mercury; and if then you take away the glaſs, and break it, you ſhall find a parcel of quickſilver, perhaps altogether, and perhaps part of it in the pores of the ſolid maſs. You ſhall find too, that the remaining lump being held to the flame of the candle, will readily burn with a greeniſh flame, and after a little while (perchance preſently) will in the air acquire a greeniſh-blue, which being the colour, that is aſcribed to copper, when its body is unlocked, it is eaſy to perſuade men, that this is the true ſulphur of *Venus*, eſpecially ſince not only the ſalts may be ſuppoſed partly to be flown away, and partly to be ſublimed to the upper part of the glaſs, (whoſe inſide will commonly appear whitened by them) but the metal ſeems to be quite deſtroyed, the copper no longer appearing in a metalline form, but almoſt in that of a reſinous lump: whereas, indeed, the caſe is only this, that the ſaline parts of the ſublimate, together with the ſal armoniac, being excited and actuated by the vehement heat, fall upon the copper, (which is a metal they can more eaſily corrode than ſilver) whereby the ſmall parts of the mercury being freed from the ſalts, that kept them aſunder, and being by the heat tumbled up and down after many occurſions, they convene into a conſpicuous maſs of liquor; and as for the ſalts, ſome of the more volatile of them ſubliming to the upper part of the glaſs, the others corrode the copper, and uniting themſelves with it, do ſtrangely alter and diſguiſe its metallick form, and compoſe with it a new kind of concrete, inflammable like ſulphur; concerning which, I ſhall not now ſay any thing, ſince I can refer you to the diligent obſervations, which I remember Mr. *Boyle* has made concerning this odd kind of verdigreaſe. But, continues *Carneades* ſmiling, you know I was not cut out for a mountebank, and therefore I will haſten to reſume the perſon of a ſceptick, and take up my diſcourſe, where you diverted me from proſecuting it.

In the next place then I conſider, that, as there are ſome bodies, which yield not ſo many as the three principles; ſo there are many others, that in their reſolution exhibit more principles than three; and that therefore the ternary number is not that of the univerſal and adequate principles of bodies. If you allow of the diſcourſe I lately made you, touching the primary aſſociations of the ſmall particles of matter, you will ſcarce think it improbable, that of ſuch elementary corpuſcles there may be more ſorts than either three, or four, or five. And if you will grant, what will ſcarce be denied, that corpuſcles of a compounded nature may, in all the wonted examples of chymiſts, paſs for elementary, I ſee not why you ſhould think it impoſſible, that aqua fortis, or aqua regis, will make a ſeparation of colliquated ſilver and gold, though the fire cannot: ſo there may be ſome agent found out ſo ſubtile and ſo powerful, at leaſt in reſpect of thoſe particular compounded corpuſcles, as to be able to reſolve them into thoſe more ſimple ones, whereof they conſiſt, and conſequently increaſe the number of the diſtinct ſubſtances, whereinto the mixed body has been hitherto thought reſoluble. And if that be true, which I recited to you a while ago out of *Helmont*, concerning the operations of the alkaheſt, which divides bodies into other diſtinct ſubſtances, both as to number and nature, than the fire does; it will not a little countenance my conjecture. But confining our ſelves to ſuch ways of analyzing mixed bodies, as are already not unknown to chymiſts, it may without abſurdity be queſtioned, whether beſides thoſe groſſer elements of bodies, which they call ſalt, ſulphur and mercury, there may not be ingredients of a more ſubtile nature, which being extremely little, and not being in themſelves viſible, may eſcape unheeded at the junctures of the diſtillatory veſſels, though never ſo carefully luted. For let me obſerve to you one thing, which, though not taken notice of by chymiſts, may be a notion of good uſe in divers caſes to a naturaliſt, that we may well ſuſpect, that there may be ſeveral ſorts of bodies, which are not immediate objects of any one of our ſenſes; ſince we ſee, that not only thoſe little corpuſcles, that iſſue out of the loadſtone, and perform the wonders, for which it is juſtly admired; but the effluviums of amber, jet, and other electrical concretes, though by their effects upon the particular bodies diſpoſed to receive their action, they ſeem to fall under the cognizance of our ſight, yet do

they

they not as electrical immediately affect any of our ſenſes, as do the bodies, whether minute or greater; that we ſee, feel, taſte, *&c.* But, (continues *Carneades*) becauſe you may expect I ſhould, as the chymiſts do, conſider only the ſenſible ingredients of mixt bodies, let us now ſee what experience will, even as to theſe, ſuggeſt to us.

IT ſeems then queſtionable enough, whether from grapes variouſly ordered there may not be drawn more diſtinct ſubſtances by the help of the fire, than from moſt other mixt bodies. For the grapes themſelves being dried into raiſins and diſtilled, will (beſides alkali, phlegm, and earth) yield a conſiderable quantity of an empyreumatical oil, and a ſpirit of a very different nature from that of wine. Alſo the unfermented juice of grapes affords other diſtilled liquors than wine doth. The juice of grapes, after fermentation, will yield a *ſpiritus ardens*; which, if competently rectified, will all burn away without leaving any thing remaining. The ſame fermented juice degenerating into vinegar yields an acid and corroding ſpirit. The ſame juice tunned up arms itſelf with tartar; out of which may be ſeparated, as out of other bodies, phlegm, ſpirit, oil, ſalt and earth: not to mention what ſubſtances may be drawn from the vine itſelf, probably differing from thoſe, which are ſeparated from tartar, which is a body by itſelf, that has few reſemblers in the world. And I will further conſider, that what force ſoever you will allow this inſtance, to evince, that there are ſome bodies, that yield more elements than others, it can ſcarce be denied, but that the major part of bodies, that are diviſible into elements, yield more than three. For, beſides thoſe, which the chymiſts are pleaſed to name hypoſtatical, moſt bodies contain two others, phlegm and earth; which concurring as well as the reſt to the conſtitution of mixts, and being as generally, if not more, found in their analyſis, I ſee no ſufficient cauſe, why they ſhould be excluded from the number of elements. Nor will it ſuffice to object, as the Paracelſians are wont to do, that the *tria prima* are the moſt uſeful elements, and the earth and water but worthleſs and unactive; for elements being called ſo, in relation to the conſtituting of mixt bodies, it ſhould be upon the account of its ingrediency, not of its uſe, that any thing ſhould be affirmed or denied to be an element: and as for the pretended uſefulneſs of earth and water, it would be conſidered, that uſefulneſs, or the want of it, denotes only a reſpect or relation to us; and therefore the preſence, or abſence of it, alters not the intrinſick nature of the thing. The hurtful teeth of vipers are, for aught I know, uſeleſs to us, and yet are not to be denied to be parts of their bodies; and it were hard to ſhew of what greater uſe to us, than phlegm and earth, are thoſe undiſcerned ſtars, which our new teleſcopes diſcover to us, in many blanched places of the ſky: and yet we cannot but acknowledge them conſtituent, and conſiderably great parts of the univerſe. Beſides that, whether or no the phlegm and earth be immediately uſeful, but neceſſary to conſtitute the body whence they are ſeparated; and conſequently, if the mixt body be not uſeleſs to us, thoſe conſtituent parts, without which it could not have been that mixed body, may be ſaid not to be unuſeful to us: and though the earth and water be not ſo conſpicuouſly operative (after ſeparation) as the other three more active principles, yet in this caſe it will not be amiſs to remember the lucky fable of *Menenius Agrippa*, of the dangerous ſedition of the hands and legs, and other more buſy parts of the body, againſt the ſeemingly unactive ſtomach. And to this caſe alſo we may not unfitly apply that reaſoning of an Apoſtle, to another purpoſe; *If the ear ſhall ſay, becauſe I am not the eye, I am not of the body; is it therefore not of the body? If the whole body were eye, where were the hearing? If the whole were for hearing, where the ſmelling?* In a word, ſince earth and water appear, as clearly and as generally as the other principles, upon the reſolution of bodies, to be the ingredients, whereof they are made up; and ſince they are uſeful (if not immediately to us, or rather to phyſicians) to the bodies they conſtitute, and ſo, though in ſomewhat a remoter way, are ſerviceable to us; to exclude them out of the number of elements, is not to imitate nature.

AND on this occaſion I cannot but take notice, that whereas the great argument, which the chymiſts are wont to employ to vilify earth and water, and make them be looked upon as uſeleſs and unworthy to be reckoned among the principles of mixed bodies, is, that they are not endowed with ſpecifick properties, but only with elementary qualities; of which they uſe to ſpeak very ſlightingly, as of qualities contemptible and unactive; I ſee no ſufficient reaſon for this practice of the chymiſts: for it is confeſſed, that heat is an elementary quality, and yet that an almoſt innumerable company of conſiderable things are performed by heat, is manifeſt to them, that duly conſider the various phænomena, wherein it intervenes as a principal actor; and none ought leſs to ignore or diſtruſt this truth than a chymiſt; ſince almoſt all the operations and productions of his art are performed chiefly by the means of heat. And as for cold it ſelf, upon whoſe account they ſo deſpiſe the earth and water, if they pleaſe to read in the voyages of our Engliſh and Dutch navigators in *Nova Zembla* and other northern regions, what ſtupendous things may be effected by cold, they would not perhaps think it ſo deſpicable. And not to repeat what I lately recited to you out of *Paracelſus* himſelf, who by the help of an intenſe cold teaches to ſeparate the quinteſſence of wine; I will only now obſerve to you, that the conſervation of the texture of many bodies, both animate and inanimate, does ſo much depend upon the convenient motion both of their own fluid and looſer parts, and of the ambient bodies, whether air, water, *&c.* that not only in human bodies we ſee, that the immoderate or unſeaſonable coldneſs of the air (eſpecially when it finds ſuch bodies over-heated) does very frequently diſcompoſe the œconomy of

them,

them, and occaſion variety of diſeaſes; but in the ſolid and durable body of iron it ſelf, in which one would not expect, that ſudden cold ſhould produce any notable change, it may have ſo great an operation, that if you take a wire, or other ſlender piece of ſteel, and having brought it in the fire to a white heat, you ſuffer it afterwards to cool leiſurely in the air, it will, when it is cold, be much of the ſame hardneſs it was of before. Whereas, if as ſoon as you remove it from the fire, you plunge it into cold water, it will upon the ſudden refrigeration acquire a very much greater hardneſs than it had before; nay, and will become manifeſtly brittle. And that you may not impute this to any peculiar quality in the water, or other liquor, or unctuous matter, wherein ſuch heated ſteel is wont to be quenched, that it may be tempered; I know a very ſkilful tradeſman, that divers times hardens ſteel by ſuddenly cooling it in a body, that is neither a liquor, nor ſo much as moiſt. A trial of that nature I remember I have ſeen made. And, however, by the operation, that water has upon ſteel quenched in it, whether upon the account of its coldneſs and moiſture, or upon that of any other of its qualities, it appears, that water is not always ſo inefficacious and contemptible a body, as our chymiſts would have it paſs for. And, what I have ſaid of the efficacy of cold and heat, might perhaps be eaſily enough carried further by other conſiderations and experiments; were it not, that having been mentioned only upon the by, I muſt not inſiſt on it, but proceed to another ſubject.

BUT (purſues *Carneades*) though I think it evident, that earth and phlegm are to be reckoned among the elements of moſt animal and vegetable bodies, yet it is not upon that account alone, that I think divers bodies reſoluble into more ſubſtances than three. For there are two experiments, that I have ſometimes made, to ſhew, that at leaſt ſome mixts are diviſible into more diſtinct ſubſtances than five. The one of theſe experiments, though it will be more ſeaſonable for me to mention it fully anon, yet in the mean time, I ſhall tell you thus much of it; that out of two diſtilled liquors, which paſs for elements of the bodies, whence they are drawn, I can, without addition, make a true yellow and inflammable ſulphur, nothwithſtanding that the two liquors remain afterwards diſtinct. Of the other experiment, which, perhaps, will not be altogether unworthy your notice, I muſt now give you this particular account: I had long obſerved, that by the diſtillation of divers woods, both in ordinary, and ſome unuſual ſorts of veſſels, the copious ſpirit, that came over, had, beſides a ſtrong taſte to be met with in the empyreumatical ſpirits of many other bodies, an acidity almoſt like that of vinegar: wherefore I ſuſpected, that though the ſouriſh liquor diſtilled, for inſtance, from box-wood, be looked upon by chymiſts as barely the ſpirit of it, and therefore as one ſingle element or principle; yet it does really conſiſt of two differing ſubſtances, and may be diviſible into them; and conſequently, that ſuch woods and other mixts, as abound with ſuch a vinegar, may be ſaid to conſiſt of one element or principle, more than the chymiſts as yet are aware of. Wherefore bethinking my ſelf, how the ſeparation of theſe two ſpirits might be made, I quickly found, that there were ſeveral ways of compaſſing it. But that of them, which I ſhall at preſent mention, was this: having diſtilled a quantity of box-wood *per ſe*, and ſlowly rectified the ſouriſh ſpirit, the better to free it both from oil and phlegm, I caſt into this rectified liquor a convenient quantity of powdered coral, expecting that the acid part of the liquor would corrode the coral, and being aſſociated with it, would be ſo retained by it, that the other part of the liquor, which was not of an acid nature, nor fit to faſten upon the corals, would be permitted to aſcend alone. Nor was I deceived in my expectation; for having gently abſtracted the liquor from the corals, there came over a ſpirit of a ſtrong ſmell, and of a taſte very piercing, but without any ſourneſs; and which was in divers qualities manifeſtly different, not only from a ſpirit of vinegar, but from ſome ſpirit of the ſame wood, that I purpoſely kept by me without depriving it of its acid ingredient. And to ſatisfy you, that theſe two ſubſtances were of a very differing nature, I might inform you of ſeveral trials, that I made, but muſt not name ſome of them, becauſe I cannot do ſo without making ſome unſeaſonable diſcoveries. Yet *this* I ſhall tell you at preſent, that the four ſpirit of box not only would, as I juſt now related, diſſolve corals, which the other would not faſten on, but being poured upon ſalt of tartar, would immediately boil and hiſs, whereas the other would lie quietly upon it. The acid ſpirit poured upon minium made a ſugar of lead, which I did not find the other to do: ſome drops of this penetrant ſpirit being mingled with ſome drops of the blue ſyrup of violets, ſeemed rather to dilute, than otherwiſe alter the colour; whereas the acid ſpirit turned the ſyrup of a reddiſh colour, and would probably have made it of as pure a red, as acid ſalts are wont to do, had not its operation been hindered by the mixture of the other ſpirit. A few drops of the compound ſpirit being ſhaken into a pretty quantity of the infuſion of lignum nephriticum, preſently deſtroyed all the bluiſh colour, whereas the other ſpirit would not take it away. To all which it might be added, that having for trial's ſake poured fair water upon the corals, that remained in the bottom of the glaſs, wherein I had rectified the double ſpirit (if I may ſo call it) that was firſt drawn from the box, I found, according to my expectation, that the acid ſpirit had really diſſolved the corals, and had coagulated with them. For by the affuſion of fair water, I obtained a ſolution, which (to note that ſingularity upon the by) was red, whence the water being evaporated, there remained a ſoluble ſubſtance much like the ordinary ſalt of coral, as chymiſts are pleaſed to call that magiſtery of corals, which they make by diſſolving them in common ſpirit of vinegar, and abſtracting

abſtracting the menſtruum *ad ſiccitatem*. I know not whether I ſhould ſubjoin on this occaſion, that the ſimple ſpirit of box, if chymiſts will have it therefore ſaline becauſe it has a ſtrong taſte, will furniſh us with a new kind of ſaline bodies, differing from thoſe hitherto taken notice of. For whereas of the three chief ſorts of ſalts, the acid, the alcalizate, and the ſulphureous, there is none, that ſeems to be friends with both the other two, as I may, ere it be long, have occaſion to ſhew; I did not find, but that the ſimple ſpirit of box did agree very well (at leaſt as far as I had occaſion to try it) both with the acid and the other ſalts. For though it would lie very quiet with ſalt of tartar, ſpirit of urine, or other bodies, whoſe ſalts were either of an alcalizate or fugitive nature; yet did not the mingling of oil of vitriol itſelf produce any hiſſing or effervescence, which you know is wont to enſue upon the affuſion of that highly acid liquor upon either of the bodies newly mentioned.

I THINK my ſelf, (ſays *Eleutherius*) beholden to you for this experiment; not only becauſe I foreſee you will make it helpful to you in the enquiry you are now upon, but becauſe it teaches us a method, whereby we may prepare a numerous ſort of new ſpirits, which though more ſimple than any that are thought elementary, are manifeſtly endowed with peculiar and powerful qualities, ſome of which may probably be of conſiderable uſe in phyſick, as well alone as aſſociated with other things; as one may hopefully gueſs by the redneſs of that ſolution your ſour ſpirit made of corals, and by ſome other circumſtances of your narrative. And ſuppoſe (purſues *Eleutherius*) that you are not ſo confined, for the ſeparation of the acid parts of theſe compound ſpirits from the other, to employ corals; but that you may as well make uſe of any alcalizate ſalt, or of pearls, or crabs eyes, or any other body, upon which common ſpirit of vinegar will eaſily work, and, to ſpeak in an *Helmontian* phraſe, exantlate it ſelf.

I HAVE not yet tried, (ſays *Carneades*) of what uſe the mentioned liquors may be in phyſick, either as medicines or as menſtruums: but I could mention now (and may another time) divers of the trials, that I made to ſatisfy my ſelf of the difference of theſe two liquors. But that, as I allow your thinking what you newly told me about corals, I preſume you will allow me, from what I have ſaid already, to deduce this corollary; that there are divers compound bodies, which may be reſolved into four ſuch differing ſubſtances, as may as well merit the name of principles, as thoſe to which the chymiſts freely give it. For ſince they ſcruple not to reckon that, which I call the compound ſpirit of box, for the ſpirit, or, as others would have it, the mercury of that wood; I ſee not, why the acid liquor, and the other, ſhould not each of them, eſpecially that laſt named, be looked upon as more worthy to be called an elementary principle; ſince it muſt needs be of a more ſimple nature than the liquor, which was found to be diviſible into that, and the acid ſpirit. And this further uſe (continues *Carneades*) may be made of our experiment to my preſent purpoſe, that it may give us a riſe to ſuſpect, that ſince a liquor reputed by the chymiſts to be, without diſpute, homogeneous, is, by ſo ſlight a way, diviſible into two diſtinct and more ſimple ingredients, ſome more ſkilful or happier experimenter than I, may find a way either further to divide one of theſe ſpirits, or to reſolve ſome or other, if not all, of thoſe other ingredients of mixt bodies, that have hitherto paſſed among chymiſts for their elements or principles.

THE SCEPTICAL CHYMIST:

PART IV.

AND thus much (ſays *Carneades*) may ſuffice to be ſaid of the number of the diſtinct ſubſtances ſeparable from mixt bodies by the fire: wherefore I now proceed to conſider the nature of them, and ſhew you, that though they ſeem homogeneous bodies, yet have they not the purity and ſimplicity that is requiſite to elements; and I ſhould immediately proceed to the proof of my aſſertion, but that the confidence, wherewith chymiſts are wont to call each of the ſubſtances we ſpeak of by the name of ſulphur or mercury, or the other of the hypoſtatical principles, and the intolerable ambiguity they allow themſelves in their writings and expreſſions, makes it neceſſary for me, in order to the keeping you either from miſtaking me, or thinking I miſtake the controverſy, to take notice to you, and complain of the unreaſonable liberty they give themſelves of playing with names at pleaſure. And indeed if I were obliged in this diſpute, to have ſuch regard to the phraſeology of each particular chymiſt, as not to write any thing, which this or that author may not pretend, not to contradict this or that ſenſe, which he may give us as occaſion ſerves to his ambiguous expreſſions, I ſhould ſcarce know how to diſpute, nor which way to turn my ſelf. For I find that even eminent writers, (ſuch as *Raymund Lully*, *Paracelſus*, and others) do ſo abuſe the terms they employ, that as they will now and then give divers things one name; ſo

they will oftentimes give one thing many names; and ſome of them (perhaps) ſuch, as do much more properly ſignify ſome diſtinct body of another kind; nay, even in technical words or terms of art, they refrain not from this confounding liberty; but will, as I have obſerved, call the ſame ſubſtance, ſometimes the ſulphur, and ſometimes the mercury of a body. And now I ſpeak of mercury, I cannot but take notice, that the deſcriptions they give us of that principle or ingredient of mixt bodies, are ſo intricate, that even thoſe, that have endeavoured to poliſh and illuſtrate the notions of the chymiſts, are fain to confeſs, that they know not what to make of it either by ingenuous acknowledgments, or deſcriptions, that are not intelligible.

I MUST confeſs, (ſays *Eleutherius*) I have, in the reading of *Paracelſus*, and other chymical authors, been troubled to find, that ſuch hard words and equivocal expreſſions, as you juſtly complain of, do, even when they treat of principles, ſeem to be ſtudiouſly affected by thoſe writers; whether to make themſelves to be admired by their readers, and their art appear more venerable and myſterious, or, (as they would have us think) to conceal from them a knowledge themſelves judge ineſtimable.

BUT whatever (ſays *Carneades*) theſe men may promiſe themſelves from a canting way of delivering the principles of nature, they will find the major part of knowing men ſo vain, as when they underſtand not what they read, to conclude, that it is rather the writer's fault than their own. And thoſe, that are ſo ambitious to be admired by the vulgar, that rather than go without the admiration of the ignorant they will expoſe themſelves to the contempt of the learned, thoſe ſhall, by my conſent, freely enjoy their option. As for the myſtical writers ſcrupling to communicate their knowledge, they might leſs to their own diſparagement, and to the trouble of their readers, have concealed it by writing no books, than by writing bad ones. If *Themiſtius* were here, he would not ſtick to ſay, that chymiſts write thus darkly, not becauſe they think their notions too precious to be explained, but becauſe they fear, that if they were explained, men would diſcern, that they are far from being precious. And indeed I fear, that the chief reaſon, why chymiſts have written ſo obſcurely of their three principles, may be, that not having clear and diſtinct notions of them themſelves, they cannot write otherwiſe than confuſedly of what they but confuſedly apprehend: not to ſay, that divers of them, being conſcious to the invalidity of their doctrine, might well enough diſcern, that they could ſcarce keep themſelves from being confuted, but by keeping themſelves from being clearly underſtood. But though much may be ſaid to excuſe the chymiſts when they write darkly, and ænigmatically, about the preparation of their elixir, and ſome few other grand arcana, the divulging of which they may, upon grounds plauſible enough, eſteem unfit; yet when they pretend to teach the general principles of natural philoſophers, this equivocal way of writing is not to be endured. For in ſuch ſpeculative enquiries, where the naked knowledge of the truth is the thing principally aimed at, what does he teach me worth thanks, that does not, if he can, make his notion intelligible to me, but by myſtical terms, and ambiguous phraſes darkens what he ſhould clear up; and makes me add the trouble of gueſſing at the ſenſe of what he equivocally expreſſes, to that of examining the truth of what he ſeems to deliver? And if the matter of the philoſopher's ſtone, and the manner of preparing it, be ſuch myſteries, as they would have the world believe them, they may write intelligibly and clearly of the principles of mixt bodies in general, without diſcovering what they call the great work. But for my part (continues *Carneades*) what my indignation at this un-philoſophical way of teaching principles has now extorted from me, is meant chiefly to excuſe my ſelf, if I ſhall hereafter oppoſe any particular opinion or aſſertion, that ſome follower of *Paracelſus* or any eminent artiſt may pretend not to be his maſter's. For, as I told you long ſince, I am not obliged to examine private men's writings, (which were a labour as endleſs as unprofitable) being only engaged to examine thoſe opinions about the *tria prima*, which I find thoſe chymiſts I have met with to agree in moſt: and I doubt not, but my arguments againſt their doctrine will be in great part eaſily enough applicable even to thoſe private opinions, which they do not ſo directly and expreſly oppoſe. And indeed, that, which I am now entering upon, being the conſideration of the things themſelves, whereinto Spagyriſts reſolve mixt bodies by the fire, if I can ſhew, that theſe are not of an elementary nature, it will be no great matter what names theſe or thoſe chymiſts have been pleaſed to give them. And I queſtion not, that to a wiſe man, and conſequently to *Eleutherius*, it will be leſs conſiderable to know, what men have thought of things, than what they ſhould have thought.

IN the fourth and laſt place, then, I conſider, that as generally as chymiſts are wont to appeal to experience, and as confidently as they uſe to inſtance the ſeveral ſubſtances ſeparated by the fire from a mixt body, as a ſufficient proof of their being its component elements; yet thoſe differing ſubſtances are many of them far enough from elementary ſimplicity, and may be yet looked upon as mixt bodies, moſt of them alſo retaining, ſomewhat at leaſt, if not very much, of the nature of thoſe concretes whence they were forced. I am glad (ſays *Eleutherius*) to ſee the vanity or envy of the canting chymiſts thus diſcovered and chaſtiſed; and I could wiſh, that learned men would conſpire together to make theſe deluding writers ſenſible, that they muſt no longer hope with impunity to abuſe the world. For whilſt ſuch men are quietly permitted to publiſh books with promiſing titles, and therein to aſſert what they pleaſe, and contradict others, and even themſelves as they pleaſe, with as little danger of being confuted as of being underſtood, they are encouraged to get themſelves a name, at the

coſt

coſt of the readers, by finding, that intelligent men are wont, for the reaſon newly mentioned, to let their books and them alone: and the ignorant and credulous (of which the number is ſtill much greater than that of the other) are forward to admire moſt what they leaſt underſtand. But if judicious men, ſkilled in chymical affairs, ſhall once agree to write clearly and plainly of them, and thereby keep men from being ſtunned, as it were, or impoſed upon by dark or empty words; it is to be hoped, that theſe men finding, that they can no longer write impertinently and abſurdly, without being laughed at for doing ſo, will be reduced either to write nothing, or books, that may teach us ſomething, and not rob men, as formerly, of invaluable time; and ſo ceaſing to trouble the world with riddles or impertinencies, we ſhall either by their books receive an advantage, or by their ſilence eſcape an inconvenience.

BUT after all this is ſaid (continues *Eleutherius*) it may be repreſented in favour of the chymiſts, that, in one regard the liberty they take in uſing names, if it be excuſable at any time, may be more ſo when they ſpeak of the ſubſtances, whereinto their analyſis reſolves mixt bodies: ſince as parents have the right to name their own children, it has ever been allowed to the authors of new inventions, to impoſe names upon them. And therefore the ſubjects we ſpeak of being ſo the productions of the chymiſts art, as not to be otherwiſe, but by it, obtainable; it ſeems but equitable to give the artiſts leave to name them as they pleaſe: conſidering alſo, that none are ſo fit and likely to teach us what thoſe bodies are, as they to whom we owed them.

I TOLD you already (ſays *Carneades*) that there is great difference betwixt the being able to make experiments, and the being able to give a philoſophical account of them. And I will not now add, that many a mine-digger may meet, whilſt he follows his work, with a gem or a mineral which he knows not what to make of, till he ſhews it a jeweller or a mineraliſt to be informed what it is. But that which I would rather have here obſerved, is, that the chymiſts I am now in debate with have given up the liberty you challenged for them, of uſing names at pleaſure, and confined themſelves by their deſcriptions, though but ſuch as they are, of their principles; ſo that although they might freely have called any thing their analyſis preſents them with, either ſulphur, or mercury, or gas, or blas, or what they pleaſed; yet when they have told me, that ſulphur (for inſtance) is a primogeneal and ſimple body, inflammable, odorous, *&c.* they muſt give me leave to diſbelieve them, if they tell me, that a body, that is either compounded or uninflammable, is ſuch a ſulphur; and to think they play with words, when they teach, that gold and ſome other minerals abound with an incombuſtible ſulphur, which is as proper an expreſſion, as a ſun-ſhine night, or a fluid ice.

BUT before I deſcend to the mention of particulars belonging to my fourth conſideration, I think it convenient to premiſe a few generals; ſome of which I ſhall the leſs need to inſiſt on at preſent, becauſe I have touched on them already.

AND firſt I muſt invite you to take notice of a certain paſſage in *Helmont* *; which though I have not found much heeded by his readers, he himſelf mentions as a notable thing, and I take to be a very conſiderable one: for whereas the diſtilled oil of oil-olive, though drawn *per ſe*, is (as I have tried) of a very ſharp and fretting quality, and of an odious taſte, he tells us, that ſimple oil being only digeſted with *Paracelſus*'s *ſal circulatum*, is reduced into diſſimilar parts, and yields a ſweet oil, very differing from the oil diſtilled from ſallet oil; as alſo, that by the ſame way there may be ſeparated from wine a very ſweet and gentle ſpirit, partaking of a far other and nobler quality than that which is immediately drawn by diſtillation, and called dephlegmed aqua vitæ, from whoſe acrimony this other ſpirit is exceedingly remote; although the *ſal circulatum* that makes theſe anatomies be ſeparated from the analyzed bodies, in the ſame weight and with the ſame qualities it had before. Which affirmation of *Helmont*, if we admit to be true, we muſt acknowledge, that there may be a very great diſparity betwixt bodies of the ſame denomination (as ſeveral oils, or ſeveral ſpirits) ſeparable from compound bodies: for beſides the differences I ſhall anon take notice of, betwixt thoſe diſtilled oils that are commonly known to chymiſts, it appears by this, that by means of the *ſal circulatum*, there may be quite another ſort of oils obtained from the ſame body: and who knows, but that there may be yet other agents bound in nature, by whoſe help there may, whether by tranſmutation or otherwiſe, be obtained from the bodies vulgarly called mixt, oils or other ſubſtances, differing from thoſe of the ſame denomination, known either to vulgar chymiſts, or even to *Helmont* himſelf? But for fear you ſhould tell me, that this is but a conjecture grounded upon another man's relation, whoſe truth we have not the means to experiment, I will not inſiſt upon it; but leaving you to conſider of it at leiſure, I ſhall proceed to what is next.

SECONDLY, then, if that be true, which was the opinion of *Leucippus*, *Democritus*, and other prime anatomiſts of old, and is in our days revived by no mean philoſophers; namely, that our culinary fire, ſuch as chymiſts uſe, conſiſts of ſwarms of little bodies ſwiftly moving, which by their ſmallneſs and motion are able to permeate the ſolideſt and compacteſt bodies, and

* *Illud notabile, in vino eſſe ſpiritum quendam mitiorem ulterioris & nobilioris qualitatis participem, quam qui immediatè per diſtillationem elicitur, diciturque aqua vitæ dephlegmata, quid facilius in ſimplici olivarum oleo ad oculum ſpectatur. Quippe diſtillatum oleum abſque lateorum aut tegularum additamento, quodque oleum philoſophorum dicitur, multum differt ab ejus oleitate, quæ elicitur prius reductio oleo ſimplici in partes diſſimilares ſola digeſtione & ſalis circulati Paracelſici appoſitione; ſi quidem ſal circulatum idem in pondere & quantitatibus priſtinis ab oleo ſegregatur, poſtquam oleum olivarum in ſui heterogeneitates eſt diſpoſitum. Dulce enim tunc oleum olivarum ex oleo, prout & ſuaviſſimus vini ſpiritus à vino hoc pacto ſeparantur, longeque in aquæ vitæ acrimonia diſtinctus.* Helmont. Aura vitalis, pag. 725.

and even glaſs it ſelf; if this (I ſay) be true, ſince we ſee, that in flints and other concretes, the fiery part is incorporated with the groſſer, it will not be irrational to conjecture, that multitudes of theſe fiery corpuſcles, getting in at the pores of the glaſs, may aſſociate themſelves with the parts of the mixt body whereon they work, and with them conſtitute new kinds of compound bodies, according as the ſhape, ſize, and other affections of the parts of the diſſipated body happen to diſpoſe them, in reference to ſuch combinations; of which alſo there may be the greater number, if it be likewiſe granted, that the corpuſcles of the fire, though all exceeding minute, and very ſwiftly moved, are not all of the ſame bigneſs, nor figure: and if I had not weightier conſiderations to diſcourſe to you of, I could name to you, to countenance what I have newly ſaid, ſome particular experiments, by which I have been induced to think, that the particles of an open fire working upon ſome bodies may really aſſociate themſelves therewith, and add to the quantity. But becauſe I am not ſure, that when the fire works upon bodies included in glaſſes, it does it by a real trajection of the fiery corpuſcles themſelves, through the ſubſtance of the glaſs, I will proceed to what is next to be mentioned.

I COULD (ſays *Eleutherius*) help you to ſome proofs, whereby I think it may be made very probable, that when the fire acts immediately upon a body, ſome of its corpuſcles may ſtick to thoſe of the burnt body, as they ſeem to do in quick-lime, but in greater numbers and more permanently. But for fear of retarding your progreſs, I ſhall deſire you to defer this inquiry till another time, and proceed as you intended.

YOU may then, in the next place, (ſays *Carneades*) obſerve with me, that not only there are ſome bodies, as gold, and ſilver, which do not by the uſual examens, made by fire, diſcover themſelves to be mixt; but if (as you may remember I formerly told you) it be a de-compound body, that is diſſipable into ſeveral ſubſtances, by being expoſed to the fire it may be reſolved into ſuch, as are neither elementary, nor ſuch as it was upon its laſt mixture compounded of; but into new kinds of mixts. Of this I have already given you ſome examples in ſoap, ſugar of lead, and vitriol. Now if we ſhall conſider, that there are ſome bodies, as well natural, (as that I laſt named) as factitious, manifeſtly de-compounded; that in the bowels of the earth nature may, as we ſee ſhe ſometimes does, make ſtrange mixtures; that animals are nouriſhed with other animals and plants; and that theſe themſelves have almoſt all of them their nutriment and growth, either from a certain nitrous juice harboured in the pores of the earth, or from the excrements of animals, or from the putrified bodies, either of living creatures or vegetables, or from other ſubſtances of a compounded nature; if, I ſay, we conſider this, it may ſeem probable, that there may be among the works of nature (not to mention thoſe of art) a greater number of de-compound bodies, than men take notice of; and indeed, as I have formerly alſo obſerved, it does not at all appear, that all mixtures muſt be of elementary bodies; but it ſeems far more probable, that there are divers ſorts of compound bodies, even in regard of all or ſome of their ingredients, conſidered antecedently to their mixture. For though ſome ſeem to he made up by the immediate coalitions of the elements, or principles themſelves, and therefore may be called *prima miſta*, or *miſta primaria*; yet it ſeems, that many other bodies are mingled (if I may ſo ſpeak) at the ſecond hand, their immediate ingredients being not elementary, but theſe primary mixt newly ſpoken of; and from divers of thoſe ſecondary ſorts of mixts may reſult, by a further compoſition, a third ſort, and ſo onwards. Nor is it improbable, that ſome bodies are made up of mixt bodies, not all of the ſame order, but of ſeveral; as (for inſtance) a concrete may conſiſt of ingredients, whereof the one may have been a primary, the other a ſecondary mixt body; (as I have in native cinnaber, by my way of reſolving it, found both that coarſer part, that ſeems more properly to be ore, and a combuſtible ſulphur, and a running mercury:) or perhaps without any ingredient of this latter ſort, it may be compoſed of mixt bodies, ſome of them of the firſt, and ſome of the third kind. And this may perhaps be ſomewhat illuſtrated by reflecting upon what happens in ſome chymical preparations of thoſe medicines which they call their bezoardicum's. For firſt, they take antimony and iron, which may be looked upon as *prima miſta*; of theſe they compound a ſtarry regulus, and to this they add, according to their intention, either gold or ſilver, which makes with it a new and further compoſition. To this they add ſublimate, which is itſelf a de-compound body, (conſiſting of common quickſilver, and divers ſalts united by ſublimation into a cryſtalline ſubſtance) and from this ſublimate, and the other metalline mixtures, they draw a liquor, which may be allowed to be of a yet more compounded nature. If it be true, as chymiſts affirm it, that by this art ſome of the gold or ſilver mingled with the regulus may be carried over the helm with it by the ſublimate; as indeed a ſkilful and candid perſon complained to me a while ſince, that an experienced friend of his and mine, having by ſuch a way brought over a great deal of gold, in hope to do ſomething further with it, which might be gainful to him, has not only miſſed of his aim, but is unable to recover his volatilized gold out of the antimonial butter, wherewith it is ſtrictly united.

NOW (continues *Carneades*) if a compound body conſiſt of ingredients, that are not merely elementary; it is not hard to conceive, that the ſubſtances, into which the fire diſſolves it, though ſeemingly homogeneous enough, may be of a compounded nature, thoſe parts of each body, that are moſt of kin, aſſociating themſelves into a compound of a new kind. As when (for example ſake) I have cauſed vitriol and ſal armoniac, and ſalt-petre to be mingled and diſtilled together, the liquor, that came over, manifeſted it ſelf not to be either ſpirit of nitre,

nitre, or of ſal armoniac, or of vitriol. For none of theſe would diſſolve crude gold, which yet my liquor was able readily to do; and thereby manifeſted it ſelf to be a new compound, conſiſting at leaſt of ſpirit of nitre, and ſal armoniac, (for the latter diſſolved in the former, will work on gold) which nevertheleſs are not by any known way ſeparable, and conſequently would not paſs for a mixt body, if we our ſelves did not, to obtain it, put and diſtill together divers concretes, whoſe diſtinct operations were known beforehand. And to add on this occaſion the experiment I lately promiſed you, becauſe it is applicable to our preſent purpoſe, I ſhall acquaint you, that ſuſpecting the common oil of vitriol not to be altogether ſuch a ſimple liquor, as chymiſts preſume it, I mingled it with an equal or a double quantity (for I tried the experiment more than once) of common oil of turpentine, ſuch as together with the other liquor I bought at the drugſters. And having carefully (for the experiment is nice, and ſomewhat dangerous) diſtilled the mixture in a ſmall glaſs retort, I obtained, according to my deſire, (beſides the two liquors I had put in) a pretty quantity of a certain ſubſtance, which ſticking all about the neck of the retort, diſcovered it ſelf to be ſulphur, not only by a very ſtrong ſulphureous ſmell, and by the colour of brimſtone; but alſo by this, that being put upon a coal, it was immediately kindled, and burned like common ſulphur. And of this ſubſtance I have yet by me ſome little parcels, which you may command and examine when you pleaſe. So that from this experiment I may deduce either one, or both of theſe propoſitions, that a real ſulphur may be made by the conjunction of two ſuch ſubſtances as chymiſts take for elementary, and which did not either of them apart appear to have any ſuch body in it; or, that oil of vitriol, though a diſtilled liquor, and taken for part of the ſaline principle of the concrete, that yields it, may yet be ſo compounded a body, as to contain, beſides its ſaline part, a ſulphur like common brimſtone, which would hardly be itſelf a ſimple or un-compounded body.

I MIGHT (purſues *Carneades*) remind you, that I formerly repreſented it as poſſible, that as there may be more elements than five, or ſix; ſo the elements of one body may be different from thoſe of another: whence it would follow, that from the reſolution of de-compound bodies there may reſult mixts of an altogether new kind, by the coalition of elements, that never perhaps convened before. I might, I ſay, mind you of this, and add divers things to this ſecond conſideration; but for fear of wanting time, I willingly pretermit them, to paſs on to the third, which is this, that the fire does not always barely reſolve or take aſunder, but may alſo after a new manner mingle and compound together the parts (whether elementary or not) of the body diſſipated by it.

THIS is ſo evident (ſays *Carneades*) in ſome obvious examples, that I cannot but wonder at their ſupineneſs, that have not taken notice of it. For when wood being burnt in a chimney is diſſipated by the fire into ſmoke and aſhes, that ſmoke compoſes ſoot, which is ſo far from being any one of the principles of the wood, that (as I noted above) you may by a further analyſis ſeparate five or ſix diſtinct ſubſtances from it. And as for the remaining aſhes, the chymiſts themſelves teach us, that by a further degree of fire they may be indiſſolubly united into glaſs. It is true, that the analyſis, which the chymiſts principally build upon, is made, not in the open air, but in cloſe veſſels; but however, the examples lately produced may invite you ſhrewdly to ſuſpect, that heat may as well compound as diſſipate the parts of mixt bodies: and not to tell you, that I have known a vitrification made even in cloſe veſſels, I muſt remind you, that the flowers of antimony, and thoſe of ſulphur, are very mixt bodies, though they aſcend in cloſe veſſels; and that it was in ſtopt glaſſes, that I brought up the whole body of camphire. And whereas it may be objected, that all theſe examples are of bodies forced up in a dry, not a fluid form, as are the liquors wont to be obtained by diſtillation; I anſwer, that beſides it is poſſible, that a body may be changed from conſiſtent to fluid, or from fluid to conſiſtent, without being otherwiſe much altered, as may appear by the eaſineſs, wherewith in winter, without any addition or ſeparation of viſible ingredients, the ſame ſubſtance may be quickly hardened into brittle ice, and thawed again into fluid water; beſides this, I ſay, it would be conſidered, that common quickſilver itſelf, which the eminenteſt chymiſts confeſs to be a mixt body, may be driven over the helm in its priſtine form of quickſilver, and conſequently, in that of a liquor. And certainly it is poſſible, that very compounded bodies may concur to conſtitute liquors; ſince, not to mention, that I have found it poſſible, by the help of a certain menſtruum, to diſtill gold it ſelf through a retort, even with a moderate fire; let us but conſider what happens in butter of antimony. For if that be carefully rectified, it may be reduced into a very clear liquor; and yet if you caſt a quantity of fair water upon it, there will quickly precipitate a ponderous and vomitive calx, which made before a conſiderable part of the liquor, and yet is indeed (though ſome eminent chymiſts would have it mercurial) an antimonial body, carried over and kept diſſolved by the ſalts of the ſublimate, and conſequently a compounded one; as you may find, if you will have the curioſity to examine this white powder by a ſkilful reduction. And that you may not think, that bodies, as compounded as flowers of brimſtone, cannot be brought to concur to conſtitute diſtilled liquors; and alſo, that you may not imagine, with divers learned men, that pretend no ſmall ſkill in chymiſtry, that at leaſt no mixt body can be brought over the helm, but by corroſive ſalts; I am ready to ſhew you, when you pleaſe, among other ways of bringing over flowers of brimſtone (perhaps I might add, even mineral ſulphurs) ſome, wherein I employ none but oleaginous bodies to make volatile liquors, in which not only the colour, but (which is a much ſurer mark) the ſmell and ſome operations manifeſt, that there

is brought over a ſulphur, that makes part of the liquor.

ONE thing more there is, *Eleutherius*, (ſays *Carneades*) which is ſo pertinent to my preſent purpoſe, that, though I have touched upon it before, I cannot but on this occaſion take notice of it. And it is this; that the qualities or accidents, upon whoſe account chymiſts are wont to call a portion of matter by the name of mercury, or ſome other of their principles, are not ſuch, but that it is poſſible as great (and therefore why not the like?) may be produced by ſuch changes of texture, and other alterations, as the fire may make in the ſmall parts of a body. I have already proved, when I diſcourſed of the ſecond general conſideration, by what happens to plants nouriſhed only with fair water, and eggs hatched into chickens, that by changing the diſpoſition of the component parts of a body, nature is able to effect as great changes in a parcel of matter reputed ſimilar, as thoſe requiſite to denominate one of the *tria prima*. And, though *Helmont* do ſomewhere wittily call the fire the deſtructor and the artificial death of things; and, although another eminent chymiſt and phyſician be pleaſed to build upon this, that fire can never generate any thing but fire; yet you will, I doubt not, be of another mind, if you conſider, how many new ſorts of mixed bodies chymiſts themſelves have produced by means of the fire; and particularly, if you conſider, how that noble and permanent body, glaſs, is not only manifeſtly produced by the violent action of the fire, but has never, for aught we know, been produced any other way. And, indeed, it ſeems but an inconſiderate aſſertion of ſome Helmontians, that every ſort of body of a peculiar denomination muſt be produced by ſome ſeminal power; as I think I could evince, if I thought it ſo neceſſary, as it is for me to haſten to what I have further to diſcourſe. Nor need it much move us, that there are ſome, who look upon whatſoever the fire is employed to produce, not as upon natural, but artificial bodies. For there is not always ſuch a difference, as many imagine, betwixt the one and the other; nor is it ſo eaſy as they think, clearly to aſſign that, which properly, conſtantly, and ſufficiently, diſcriminates them. But not to engage my ſelf in ſo nice a diſquiſition, it may now ſuffice to obſerve, that a thing is commonly termed artificial, when a parcel of matter is by the artificer's hand, or tools, or both, brought to ſuch a ſhape or form, as he deſigned before-hand in his mind: whereas in many of the chymical productions the effect would be produced, whether the artificer intended it or no; and is oftentimes very much other than he intended or looked for: and the inſtruments employed are not tools artificially faſhioned and ſhaped, like thoſe of tradeſmen, for this or that particular work; but, for the moſt part, agents of nature's own providing, and whoſe chief powers of operation they receive from their own nature or texture, not the artificer. And, indeed, the fire is as well a natural agent as ſeed: and the chymiſt; that imploys it, does but apply natural agents and patients, who being thus brought together, and acting according to their reſpective natures, perform the work themſelves; as apples, plums, or other fruit, are natural productions, though the gardener bring and faſten together the ſcions and the ſtock, and both water, and do perhaps divers other ways contribute to its bearing fruit. But, to proceed to what I was going to ſay; you may obſerve with me, *Eleutherius*, that, as I told you once before, qualities ſlight enough may ſerve to denominate a chymical principle. For, when they anatomize a compound body by the fire, if they get a ſubſtance inflammable, and that will not mingle with water, that they preſently call ſulphur; what is ſapid and diſſoluble in water, that muſt paſs for ſalt; whatſoever is fixed and indiſſoluble in water, that they name earth. And I was going to add, that whatſoever volatile ſubſtance they know not what to make of, not to ſay, whatſoever they pleaſe, that they call mercury. But that theſe qualities may either be produced, otherwiſe than by ſuch as they call ſeminal agents, or may belong to bodies of a compounded nature, may be ſhewn, among other inſtances, in glaſs made of aſhes, where the exceeding ſtrong-taſted alcalizate ſalt joining with the earth becomes inſipid, and with it conſtitutes a body; which, though alſo dry, fixed and indiſſoluble in water, is yet manifeſtly a mixed body; and made ſo by the fire it ſelf.

AND I remember to our preſent purpoſe, that *Helmont*, amongſt other medicines that he commends, has a ſhort proceſs, wherein, though the directions for practice are but obſcurely intimated, yet I have ſome reaſon not to diſbelieve the proceſs, without affirming or denying any thing about the virtues of the remedy to be made by it. *Quando* (ſays he) *oleum cinnamomi, &c. ſuo ſali alkali miſcetur abſque omni aqua, trium menſium artificioſa occultaque circulatione, totum in ſalem volatilem commutatum eſt, vere eſſentiam ſui ſimplicis in nobis exprimit, & uſque in prima noſtri conſtitutiva ſeſe ingerit.* A not unlike proceſs he delivers in another place; from whence, if we ſuppoſe him to ſay true, I may argue, that ſince by the fire there may be produced a ſubſtance, that is as well ſaline and volatile, as the ſalt of hartſhorn, blood, *&c.* which paſs for elementary; and ſince that this volatile ſalt is really compounded of a chymical oil and a fixed ſalt, the one made volatile by the other, and both aſſociated by the fire, it may well be ſuſpected, that other ſubſtances, emerging upon the diſſipation of bodies by the fire, may be new ſorts of mixts, and conſiſt of ſubſtances of differing natures: and particularly, I have ſometimes ſuſpected, that ſince the volatile ſalts of blood, hartſhorn, *&c.* are fugitive, and endowed with an exceeding ſtrong ſmell, either that chymiſts do erroneouſly aſcribe all odours to ſulphurs, or that ſuch ſalts conſiſt of ſome oily parts well incorporated with the ſaline ones. And the like conjecture I have alſo made concerning ſpirit of vinegar, which though the chymiſts think one of the principles of that body, and though being an acid ſpirit it ſeems to be much leſs

Helmont p. 412.

of

of kin, than volatile ſalts, to ſulphurs; yet, not to mention its piercing ſmell, which I know not with what congruity the chymiſts will deduce from ſalt, I wonder they have not taken notice of what their own *Tyrocinium Chymicum* teaches us concerning the diſtillation of *ſaccharum Saturni*; out of which, *Beguinus* aſſures us, that he diſtilled, beſides a very fine ſpirit, no leſs than two oils, the one blood-red and ponderous, but the other ſwimming upon the top of the ſpirit, and of a yellow colour; of which, he ſays, that he kept then ſome by him, to verify what he delivers. And though I remember not, that I have had two diſtinct oils from ſugar of lead, yet that it will, though diſtilled without addition, yield ſome oil, diſagrees not with my experience. I know the chymiſts will be apt to pretend, that theſe oils are but the volatilized ſulphur of lead; and will perhaps argue it from what *Beguinus* relates, that when the diſtillation is ended, you'll find a *caput mortuum* extremely black, and (as he ſpeaks) *nullius momenti*, as if the body, or at leaſt the chief part of the metal it ſelf, were by the diſtillation carried over the helm. But ſince you know, as well as I, that *ſaccharum Saturni* is a kind of magiſtery, made only by calcining of lead *per ſe*, diſſolving it in diſtilled vinegar, and cryſtallizing the ſolution; if I had leiſure to tell you, how differing a thing I did, upon examination, find the *caput mortuum*, ſo ſlighted by *Beguinus*, to be, from what he repreſents it, I believe you would think the conjecture propoſed leſs probable than one or other of theſe three; either that this oil did formerly concur to conſtitute the ſpirit of vinegar, and ſo that what paſſes for a chymical principle, may yet be further reſoluble into diſtinct ſubſtances; or that ſome parts of the ſpirit, together with ſome parts of the lead, may conſtitute a chymical oil, which therefore, though it paſs for homogeneous, may be a very compounded body; or at leaſt, that by the action of the diſtilled vinegar and the ſaturnine calx one upon another, part of the liquor may be ſo altered, as to be tranſmuted from an acid ſpirit into an oil. And though the truth of either of the two former conjectures would make the example I have reflected on, more pertinent to my preſent argument; yet you'll eaſily diſcern, the third and laſt conjecture cannot be unſerviceable to confirm ſome other paſſages of my diſcourſe.

Tyroc. Chym. L. 1. C. 4.

To return then to what I was ſaying juſt before I mentioned *Helmont*'s experiment; I ſhall ſubjoin, that chymiſts muſt confeſs alſo, that in the perfectly dephlegmed ſpirit of wine, or other fermented liquors, that, which they call the ſulphur of the concrete, loſes, by the fermentation, the property of oil, (which the chymiſts likewiſe take to be the true ſulphur of the mixt) of being unmingleable with the water. And if you will credit **Helmont*, a pound of the pureſt ſpirit of wine may barely, by the help of pure ſalt of tartar, (which is but the fixed ſalt of wine) be reſolved or tranſmuted into ſcarce half an ounce of ſalt, and as much elementary water, as amounts to the remaining part of the mentioned weight. And it may (as I think I formerly alſo noted) be doubted, whether that fixed and alcalizate ſalt, which is ſo unanimouſly agreed on, to be the ſaline principle of incinerated bodies, be not, as it is alcalizate, a production of the fire? For though the taſte of tartar, for example, ſeem to argue, that it contains a ſalt before it be burned; yet that ſalt being very acid, is of a quite differing taſte from the lixiviate ſalt of calcined tartar. And though it be not truly objected againſt the chymiſts, that they obtain all ſalts they make, by reducing the body they work on into aſhes with violent fires, (ſince hartſhorn, amber, blood, and divers other mixts, yield a copious ſalt, before they be burned to aſhes) yet this volatile ſalt differs much, as we ſhall ſee anon, from the fixed alcalizate ſalt I ſpeak of; which, for aught I remember, is not producible by any known way, without incineration. It is not unknown to chymiſts, that quickſilver may be precipitated, without addition, into a dry powder, that remains ſo in water. And ſome eminent Spagyriſts, and even *Raimund Lully* himſelf, teach, that meerly by the fire, quickſilver may in convenient veſſels be reduced (at leaſt in great part) into a thin liquor like water, and mingleable with it. So that by the bare action of the fire, it is poſſible, that the parts of a mixed body ſhould be ſo diſpoſed after new and differing manners, that it may be ſometimes of one conſiſtence, ſometimes of another; and may in one ſtate be diſpoſed to be mingled with water, and in another not. I could alſo ſhew you, that bodies, from which apart chymiſts cannot obtain any thing, that is combuſtible, may, by being aſſociated together, and by the help of the fire, afford an inflammable ſubſtance. And, that on the other ſide, it is poſſible for a body to be inflammable, from which it would very much puzzle any ordinary chymiſt, and perhaps any other, to ſeparate an inflammable principle or ingredient. Wherefore, ſince the principles of chymiſts may receive their denominations from qualities, which it often exceeds not the power of art, nor always that of the fire to produce; and ſince ſuch qualities may be found in bodies, that differ ſo much in other qualities from one another, that they need not be allowed to agree in that pure and ſimple nature, which principles, to be ſo indeed, muſt have; it may juſtly be ſuſpected, that many productions of the fire, that are ſhewed us by chymiſts, as the principles of the concrete, that afforded them, may be but a new kind of mixts. And to annex, on this occaſion, to theſe arguments taken from the nature of the thing, one of thoſe, which logicians call *ad hominem*, I ſhall deſire you to take notice, that though *Paracelſus* himſelf, and ſome, that are ſo miſtaken, as to think he could not be ſo, have ventured to teach, that not only the bodies here below, but the elements themſelves, and all the other parts of the univerſe, are compoſed of ſalt, ſulphur

* *Oſtendi aliàs, quomodo lib. una aquæ vitæ combibita in ſale tartari ſiccato, vix fiat ſemuncia ſalis, cæterum totum corpus fiat aqua elementalis.* Helmont. in Aura vitali.

ſulphur and mercury; yet the learned *Sennertus*, and all the more wary chymiſts, have rejected that conceit, and do many of them confeſs, that the *tria prima* are each of them made up of the four elements; and others of them make earth and water concur with ſalt, ſulphur and mercury, to the conſtitution of mixt bodies. So that one ſort of theſe Spagyriſts, notwithſtanding the ſpecious titles they give to the productions of the fire, do in effect grant what I contend for. And, of the other ſort I may well demand, to what kind of bodies the phlegm and dead earth, to be met with in chymical reſolutions, are to be referred? For either they muſt ſay, with *Paracelſus*, but againſt their own conceſſions, as well as againſt experience, that theſe are alſo compoſed of the *tria prima*, whereof they cannot ſeparate any one from either of them; or elſe they muſt confeſs, that two of the vaſteſt bodies here below, earth and water, are neither of them compoſed of the *tria prima*; and that conſequently thoſe three are not the univerſal, and adequate ingredients, neither of all ſublunary bodies, nor even of all mixed bodies.

I KNOW, that the chief of theſe chymiſts repreſent, that though the diſtinct ſubſtances into which they divide mixt bodies by the fire, are not pure and homogeneous; yet ſince the four elements, into which the Ariſtotelians pretend to reſolve the like bodies by the ſame agent, are not ſimple neither, as themſelves acknowledge, it is as allowable for the chymiſts to call the one *principles*, as for the Peripateticks to call the other *elements*; ſince in both caſes the impoſition of the name is grounded only upon the predominancy of that element, whoſe name is aſcribed to it. Nor ſhall I deny, that this argument of the chymiſts is no ill one againſt the Ariſtotelians. But what anſwer can it prove to me, who, you know, am diſputing as well againſt the Ariſtotelian elements, as the chymical principles, and muſt not look upon any body as a true principle or element, but as yet compounded, which is not perfectly homogeneous, but is further reſoluble into any number of diſtinct ſubſtances, how ſmall ſoever? And as for the chymiſts calling a body ſalt, or ſulphur, or mercury, upon pretence, that the principle of the ſame name is predominant in it, that itſelf is an acknowledgment of what I contend for; namely, that theſe productions of the fire are yet compounded bodies. And yet whilſt this is granted, it is affirmed, but not proved, that the reputed ſalt, or ſulphur, or mercury, conſiſts mainly of one body, that deſerves the name of a principle of the ſame denomination. For how do chymiſts make it appear, that there are any ſuch primitive and ſimple bodies in thoſe we are ſpeaking of; ſince it is upon the matter confeſſed by the anſwer lately made, that theſe are not ſuch? And if they pretend by reaſon to evince what they affirm, what becomes of their confident boaſts, that the chymiſt (whom they therefore, after *Beguinus*, call a *philoſophus* or *opifex ſenſatus*) can convince our eyes, by manifeſtly ſhewing in any mixt body thoſe ſimple ſubſtances he teaches them to be compoſed of? And indeed, for the chymiſts to have recourſe in this caſe to other proofs than experiments, as it is to wave the grand argument, that has all this while been given out for a demonſtrative one; ſo it releaſes me from the obligation to proſecute a diſpute, wherein I am not engaged to examine any but experimental proofs. I know it may plauſibly enough be repreſented, in favour of the chymiſts, that it being evident, that much the greater part of any thing they call ſalt, or ſulphur, or mercury, is really ſuch; it would be very rigid to deny thoſe ſubſtances the names aſcribed them, only becauſe of ſome ſlight mixture of another body, ſince not only the Peripateticks call particular parcels of matter elementary, though they acknowledge, that elements are not to be any where found pure, at leaſt here below, and ſince eſpecially there is a manifeſt analogy and reſemblance betwixt the bodies obtainable by chymical anatomies, and the principles whoſe names are given them; I have, I ſay, conſidered that theſe things may be repreſented: but as for what is drawn from the cuſtom of the Peripateticks, I have already told you, that though it may be employed againſt them, yet it is not available againſt me, who allow nothing to be an element, that is not perfectly homogeneous. And whereas it is alledged, that the predominant principle ought to give a name to the ſubſtance wherein it abounds; I anſwer, that that might much more reaſonably be ſaid, if either we or the chymiſts had ſeen nature take pure ſalt, pure ſulphur, and pure mercury, and compound of them every ſort of mixt bodies. But, ſince it is to experience that they appeal, we muſt not take it for granted, that the diſtilled oil (for inſtance) of a plant is mainly compoſed of the pure principle called ſulphur, till they have given us an ocular proof, that there is in that ſort of plants ſuch an homogeneous ſulphur. For as for the ſpecious argument, which is drawn from the reſemblance betwixt the productions of the fire, and the reſpective, either Ariſtotelian elements, or chymical principles, by whoſe names they are called; it will appear more plauſible than cogent, if you will but recall to mind the ſtate of the controverſy; which is not, whether or no there be obtained from mixt bodies certain ſubſtances, that agree in outward appearance, or in ſome qualities, with quickſilver or brimſtone, or ſome ſuch obvious or copious body; but whether or no all bodies, confeſſed to be perfectly mixt, were compoſed of, and are reſoluble into a determinate number of primary unmixt bodies. For, if you keep the ſtate of the queſtion in your eye, you will eaſily diſcern, that there is much of what ſhould be demonſtrated, left unproved by thoſe chymical experiments we are examining. But (not to repeat what I have already diſcovered more at large) I ſhall now take notice, that it will not preſently follow, that becauſe a production of the fire has ſome affinity with ſome of the greater maſſes of matter here below, that therefore they are both of the ſame nature, and deſerve the ſame name; for the chymiſts are not content, that flame ſhould be looked upon as a parcel of

the element of fire, though it be hot, dry, and active, becauſe it wants ſome other qualities belonging to the nature of elementary fire. Nor will they let the Peripateticks call aſhes, or quick-lime, earth, notwithſtanding the many likeneſſes between them; becauſe they are not taſteleſs, as elementary earth ought to be: but if you ſhould aſk me, what then it is, that all the chymical anatomies of bodies do prove, if they prove not, that they conſiſt of the three principles into which the fire reſolves them; I anſwer, that their diſſections may be granted to prove, that ſome mixt bodies (for in many it will not hold) are by the fire, when they are included in cloſe veſſels, (for that condition alſo is often requiſite) diſſoluble into ſeveral ſubſtances differing in ſome qualities, but principally in conſiſtence. So that out of moſt of them may be obtained a fixt ſubſtance, partly ſaline, and partly inſipid, an unctuous liquor, and another liquor, or more, that without being unctuous have a manifeſt taſte. Now, if chymiſts will agree to call the dry and ſapid ſubſtance, ſalt; the unctuous liquor, ſulphur; and the other, mercury; I ſhall not much quarrel with them for ſo doing: but if they will tell me, that ſalt, ſulphur, and mercury are ſimple and primary bodies, whereof each mixt body was actually compounded, and which was really in it antecedently to the operation of the fire, they muſt give me leave to doubt, whether (whatever their other arguments may do) their experiments prove all this. And if they will alſo tell me, that the ſubſtances their anatomies are wont to afford them, are pure and ſimilar, as principles ought to be, they muſt give me leave to believe my own ſenſes, and their own confeſſions, before their bare aſſertions. And that you may not (*Eleutherius*) think I deal ſo rigidly with them, becauſe I ſcruple to take theſe productions of the fire for ſuch, as the chymiſts would have them paſs for, upon the account of their having ſome affinity with them; conſider a little with me, that in regard an element or principle ought to be perfectly ſimilar and homogeneous, there is no juſt cauſe, why I ſhould rather give the body propoſed the name of this or that element or principle, becauſe it has a reſemblance to it in ſome obvious quality, rather than deny it that name upon the account of divers other qualities, wherein the propoſed bodies are unlike; and if you do but conſider, what ſlight and eaſily producible qualities they are, that ſuffice, as I have already more than once obſerved, to denominate a chymical principle or an element, you will not, I hope, think my warineſs to be deſtitute either of example, or elſe of reaſon. For we ſee, that the chymiſts will not allow the Ariſtotelians, that the ſalt in aſhes ought to be called earth, though the ſaline and terreſtrial part ſymbolize in weight, in dryneſs, in fixedneſs and fuſibility, only becauſe the one is ſapid and diſſoluble in water, and the other not: beſides, we ſee that ſapidneſs and volatility are wont to denominate the chymiſts mercury or ſpirit; and yet how many bodies, think you, may agree in thoſe qualities, which may yet be of very differing natures, and diſagree in qualities either more numerous, or more conſiderable, or both? For not only ſpirit of nitre, aqua fortis, ſpirit of ſalt, ſpirit of oil of vitriol, ſpirit of alum, ſpirit of vinegar, and all ſaline liquors diſtilled from animal bodies, but all the acetous ſpirits of woods freed from their vinegar; all theſe, I ſay, and many others muſt belong to the chymiſts mercury, though it appear not, why ſome of them ſhould more be comprehended under one denomination than the chymiſts ſulphur, or oil, ſhould likewiſe be; for their diſtilled oils are alſo fluid, volatile, and taſteable, as well as their mercury: nor is it neceſſary, that their ſulphur ſhould be unctuous or diſſoluble in water, ſince they generally refer ſpirit of wine to ſulphurs, although that ſpirit be not unctuous, and will freely mingle with water. So that bare inflammability muſt conſtitute the eſſence of the chymiſts ſulphur; as uninflammableneſs, joined with any taſte, is enough to intitle a diſtilled liquor to be their mercury. Now ſince I can further obſerve to you, that ſpirit of nitre and ſpirit of hartſhorn being poured together will boil and hiſs, and toſs up one another into the air, which the chymiſts make ſigns of great antipathy in the natures of bodies, (as indeed theſe ſpirits differ much both in taſte, ſmell, and operations) ſince I elſewhere tell you of my having made two ſorts of oil out of the ſame man's blood, that would not mingle with one another; and ſince I might tell you divers examples I have met with, of the contrariety of bodies, which according to the chymiſts muſt be huddled up together under one denomination; I leave you to judge, whether ſuch a multitude of ſubſtances, as may agree in theſe ſlight qualities, and yet diſagree in others more conſiderable, are more worthy to be called by the name of a principle (which ought to be pure and homogeneous) than to have appellations given them, that may make them differ, in name too, from the bodies from which they ſo wildly differ in nature. And hence alſo, by the by, you may perceive, that it is not unreaſonable to diſtruſt the chymiſts way of argumentation, when being unable to ſhew us, that ſuch a liquor is (for example) purely ſaline, they prove, that at leaſt ſalt is much the predominant principle, becauſe that the propoſed ſubſtance is ſtrongly taſted, and all taſte proceeds from ſalt; whereas thoſe ſpirits, ſuch as ſpirit of tartar, ſpirit of hartſhorn, and the like, which are reckoned to be the mercuries of the bodies, that afford them, have manifeſtly a ſtrong and piercing taſte, and ſo has (according to what I formerly noted) the ſpirit of box &c. even after the acid liquor that concurred to compoſe it has been ſeparated from it. And indeed, if ſapidneſs belong not to the ſpirit or mercurial principle of vegetables and animals, I ſcarce know how it will be diſcriminated from their phlegm; ſince by the abſence of inflammability it muſt be diſtinguiſhed from their ſulphur: which affords me another example, to prove how unaccurate the chymical doctrine is in our preſent caſe; ſince not only the ſpirit of ve-

getables and animals, but their oils are very ſtrongly taſted, as he, that ſhall but wet his tongue with chymical oil of cinnamon or of cloves, or even turpentine, may quickly find, to his ſmart. And not only I never tried any chymical oils, whoſe taſte was not very manifeſt and ſtrong; but a ſkilful and inquiſitive perſon, who made it his buſineſs by elaborate operations to depurate chymical oils, and reduce them to an elementary ſimplicity, informs us, that he never was able to make them at all taſteleſs: whence I might infer, that the proof chymiſts confidently give us of a body's being ſaline, is ſo far from demonſtrating the predominancy, that it does not clearly evince ſo much as the preſence of the ſaline principle in it. But I will not (purſues *Carneades*) remind you, that the volatile ſalt of hartſhorn, amber, blood *&c.* are exceeding ſtrongly ſcented, notwithſtanding that moſt chymiſts deduce odours from ſulphur, and from them argue the predominancy of that principle in the odorous body; becauſe I muſt not ſo much as add any new examples of the incompetency of this ſort of chymical arguments; ſince having already detained you but too long in thoſe generals, that appertain to my fourth conſideration, it is time, that I proceed to the particulars themſelves, to which I thought fit they ſhould be previous.

THESE generals (continues *Carneades*) being thus premiſed, we might the better ſurvey the unlikeneſs, that an attentive and unprepoſſeſſed obſerver may take notice of in each ſort of bodies, which the chymiſts are wont to call the ſalts of ſulphurs or mercuries of the concretes that yield them, as if they had all a ſimplicity, and identity of nature: whereas ſalts, if they were all elementary, would as little differ as do the drops of pure and ſimple water. It is known, that both chymiſts and phyſicians aſcribe to the fixt ſalts of calcined bodies the virtues of their concretes; and conſequently very differing operations. So we find the alkali of wormwood much commended in diſtempers of the ſtomach; that of eye-bright for thoſe that have a weak ſight; and that of guaiacum (of which a great quantity yields but a very little ſalt) is not only much commended in venereal diſeaſes, but is believed to have a peculiar purgative virtue, which yet I have not had occaſion to try. And though, I confeſs, I have long thought, that theſe alkalizate ſalts are, for the moſt part, very near of kin, and retain very little of the properties of the concretes whence they were ſeparated; yet being minded to obſerve watchfully, whether I could meet with any exceptions to this general obſervation, I obſerved at the glaſs-houſe, that ſometimes the metal (as the workmen call it) or maſs of colliquated ingredients, which by blowing they faſhion into veſſels of divers ſhapes, did ſometimes prove of a very differing colour, and a ſomewhat differing texture, from what was uſual. And having inquired, whether the cauſe of ſuch accidents might not be derived from the peculiar nature of the fixt ſalt employed to bring the ſand to fuſion, I found, that the knowingeſt workmen imputed theſe miſ-adventures to the aſhes of ſome certain kind of wood, as having obſerved the ignobler kind of glaſs I lately mentioned to be frequently produced, when they had employed ſuch ſorts of aſhes, which therefore they ſcruple to make uſe of, if they took notice of them beforehand. I remember alſo, that an induſtrious man of my acquaintance having bought a vaſt quantity of tobacco-ſtalks to make a fixt ſalt with, I had the curioſity to go ſee, whether that exotick plant, which ſo much abounds in volatile ſalt, would afford a peculiar kind of alkali; and I was pleaſed to find, that in the lixivium of it it was not neceſſary, as is uſual, to evaporate all the liquor, that there might be obtained a ſaline calx, conſiſting like lime quenched in the air of a heap of little corpuſcles of unregarded ſhapes; but the fixt ſalt ſhot into figured cryſtal, almoſt as nitre or ſal armoniac and other uncalcined ſalts are wont to do. And I further remember, that I have obſerved, in the fixt ſalt of urine, brought by depuration to be very white, a taſte not ſo unlike to that of common ſalt, and very differing from the wonted cauſtick lixiviate taſte of other ſalts made by incineration. But becauſe the inſtances I have alledged of the difference of alkalizate ſalt are but few, and therefore I am ſtill inclined to think, that moſt chymiſts and many phyſicians do, inconſiderately enough, and without warrant from experience, aſcribe the virtues of the concretes expoſed to calcination, to the ſalts obtained by it; I ſhall rather, to ſhew the diſparity of ſalts, mention in the firſt place the apparent difference betwixt the vegetable fixt ſalts and the animal volatile ones: as (for example) betwixt ſalt of tartar, and ſalt of hartſhorn; whereof the former is ſo fixt, that it will indure the brunt of a violent fire, and ſtand in fuſion like a metal; whereas the other (beſides, that it has a differing taſte and a very differing ſmell) is ſo far from being fixt, that it will fly away in a gentle heat as eaſily as ſpirit of wine itſelf. And to this I ſhall add, in the next place, that even among the volatile ſalts themſelves, there is a conſiderable difference, as appears by the diſtinct properties of (for inſtance) ſalt of amber, ſalt of urine, ſalt of man's ſkull, (ſo much extolled againſt the falling ſickneſs) and divers others, which cannot eſcape an ordinary obſerver. And this diverſity of volatile ſalts I have obſerved to be ſometimes diſcernible even to the eye, in their figures. For the ſalt of hartſhorn I have obſerved to adhere to the receiver, in the form almoſt of a parallelopipedon; and of the volatile ſalt of human blood (long digeſted before diſtillation, with ſpirit of wine) I can ſhew you ſtore of grains of that figure, which geometricians call a rhombus; though I dare not undertake, that the figures of theſe or other ſaline cryſtals (if I may ſo call them) will be always the ſame, whatever degree of fire have been employed to force them up, or how haſtily ſoever they have been made to convene in the ſpirits or liquors, in the lower part of which, I have uſually obſerved them, after a while, to ſhoot. And although, as I lately told you, I ſeldom found any difference, as to medical virtues, in the fixt ſalts of divers vegetables; and accordingly I have ſuſpected

that

that moſt of theſe volatile ſalts, having ſo great a reſemblance in ſmell, in taſte, and fugitiveneſs, differ but little, if at all, in their medicinal properties: as indeed I have found them generally to agree in divers of them (as in their being ſomewhat diaphoretick and very deopilative) yet I remember * *Helmont* ſomewhere informs us, that there is this difference betwixt the ſaline ſpirit of urine and that of man's blood, that the former will not cure the epilepſy, but the latter will. Of the efficacy alſo of the ſalt of common amber againſt the ſame diſeaſe in children, (for in grown perſons it is not a ſpecifick) I may elſewhere have an occaſion to entertain you. And when I conſider, that to the obtaining of theſe volatile ſalts (eſpecially that of urine) there is not requiſite ſuch a deſtructive violence of the fire, as there is to get thoſe ſalts that muſt be made by incineration, I am the more invited to conclude, that they may differ from one another, and conſequently recede from an elementary ſimplicity. And if I could here ſhew you, what Mr. *Boyle* has obſerved, touching the various chymical diſtinctions of ſalts; you would quickly diſcern, not only that chymiſts do give themſelves a ſtrange liberty to cal lconcretes ſalts, that are, according to their own rules, to be looked upon as very compounded bodies; but that among thoſe very ſalts, that ſeem elementary, becauſe produced upon the anatomy of the bodies, that yield them, there is not only a viſible diſparity, but, to ſpeak in the common language, a manifeſt antipathy or contrariety: as is evident in the ebullition and hiſſing, that is wont to enſue, when the acid ſpirit of vitriol, for inſtance, is poured upon pot-aſhes, or ſalt of tartar. And I ſhall beg leave of this gentleman, (ſays *Carneades*) caſting his eyes on me, to let me obſerve to you, out of ſome of his papers, particularly thoſe, wherein he treats of ſome preparations of urine, that not only one and the ſame body may have two ſalts of a contrary nature, as he exemplifies in the ſpirit and alcali of nitre; but that from the ſame body there may, without addition, be obtained three differing and viſible ſalts. For he relates, that he obſerved in urine, not only a volatile and cryſtalline ſalt, and a fixt ſalt, but likewiſe a kind of ſal armoniac, or ſuch a ſalt as would ſublime in the form of a ſalt, and therefore was not fixt, and yet was far from being ſo fugitive as the volatile ſalt; from which it ſeemed alſo otherwiſe to differ. I have indeed ſuſpected, that this may be a ſal armoniac properly enough ſo called, as compounded of the volatile ſalt of urine, and the fixt of the ſame liquor, which, as I noted, is not unlike ſea-ſalt; but that it ſelf argues a manifeſt difference betwixt the ſalts, ſince ſuch a volatile ſalt is not wont to unite thus with an ordinary alkali, but to fly away from it in the heat. And on this occaſion I remember, that to give ſome of my friends an ocular proof of the difference betwixt the fixt and volatile ſalt of (the ſame concrete) wood, I deviſed the following experiment: I took common Venetian ſublimate, and diſſolved as much of it as I well could in fair water; then I took wood-aſhes, and pouring on them warm water, diſſolved their ſalt; and filtrating the water, as ſoon as I found the lixivium ſufficiently ſharp upon the tongue, I reſerved it for uſe. Then on one part of the former ſolution of ſublimate dropping a little of this diſſolved fixt ſalt of wood, the liquors preſently turned of an orange colour; but upon the other part of the clear ſolution of ſublimate putting ſome of the volatile ſalt of wood (which abounds in the ſpirit of ſoot) the liquor immediately turned white, almoſt like milk, and after a while let fall a white ſediment, as the other liquor did a yellow one. To all this that I have ſaid concerning the difference of ſalts, I might add what I formerly told you, concerning the ſimple ſpirit of box, and ſuch like woods, which differ much from the other ſalts hitherto mentioned, and yet would belong to the ſaline principle, if chymiſts did truly teach, that all taſtes proceed from it. And I might alſo annex, what I noted to you out of † *Helmont* concerning bodies, which, though they conſiſt in great part of chymical oils, do yet appear but volatile ſalts: but to inſiſt on theſe things, were to repeat; and therefore I ſhall proceed.

THIS diſparity is alſo highly eminent in the ſeparated ſulphurs or chymical oils of things. For they contain ſo much of the ſcent, and taſte, and vertues, of the bodies, whence they were drawn, that they ſeem to be but the material craſis (if I may ſo ſpeak) of their concretes. Thus the oils of cinnamon, cloves, nutmegs and other ſpices, ſeem to be but the united aromatic parts, that did enoble thoſe bodies. And it is a known thing, that oil of cinnamon, and oil of cloves, (which I have likewiſe obſerved in the oils of ſeveral woods) will ſink to the bottom of water; whereas thoſe of nutmegs and divers other vegetables will ſwim upon it. The oil (abuſively called ſpirit) of roſes ſwims at the top of the water in the form of a white butter, which I remember not to have obſerved in any other oil drawn in any limbeck; yet there is a way (not here to be declared) by which I have ſeen it come over in the form of other aromatic oils, to the delight and wonder of thoſe that beheld it. In oil of aniſeeds, which I drew both with, and without fermentation, I obſerved the whole body of the oil in a cool place to thicken into the conſiſtence and appearance of white butter, which, with the leaſt heat, reſumed its former liquidneſs. In the oil of olive drawn over in a retort, I have likewiſe more than once ſeen a ſpontaneous coagulation in the receiver: and I have of it by me thus congealed; which is of ſuch a ſtrangely penetrating ſcent, as if it would perforate the noſes that approach it. The like pungent odour I alſo obſerved in the diſtilled liquor of common ſoap, which forced over from

* *Error vero per diſtillationem nobis monſtrat etiam ſpiritum ſalinum plane volatilem odore nequicquam ut nec guſtu deſtinguibilem a ſpiritu urinæ; in eo tamen eſſentialiter diverſum, quod ſpiritus talis cruoris curat epilepſiam, non autem ſpiritus ſalis lotii.* Helmont. Aura Vitalis..

† *Aliquando oleum cinnamomi, &c. ſuo ſali alkali miſcetur abſque omni aqua, trium menſium artificioſa occultaque circulatione, totum in ſalem volatilem commutatum eſt.* Helmont. Tria Prima Chymicorum. &c. pag. 412.

from minium, lately afforded an oil of a moſt admirable penetrancy: and he muſt be a great ſtranger, both to the writings and preparations of chymiſts, that ſees not in the oils they diſtill from vegetables and animals, a conſiderable and obvious difference. Nay, I ſhall venture to add, *Eleutherius*, (what perhaps you will think of kin to a paradox) that divers times out of the ſame animal or vegetable, there may be extracted oils of natures obviouſly differing. To which purpoſe I ſhall not inſiſt on the ſwimming and ſinking oils, which I have ſometimes obſerved to float on, and ſubſide under the ſpirit of guaiacum, and that of divers other vegetables diſtilled with a ſtrong and laſting fire; nor ſhall I inſiſt on the obſervation elſewhere mentioned, of the divers and unmingleable oils afforded us by human blood, long fermented and digeſted with ſpirit of wine; becauſe theſe kinds of oils may ſeem chiefly to differ in conſiſtence and weight, being all of them high coloured and aduſt. But the experiment, which I deviſed to make out this difference of the oils of the ſame vegetable, *ad oculum*, (as they ſpeak) was this that follows: I took a pound of aniſeeds, and having groſly beaten them, cauſed them to be put into a very large glaſs retort almoſt filled with fair water; and placing this retort in a ſand-furnace, I cauſed a very gentle heat to be adminiſtered during the firſt day, and a great part of the ſecond, till the water was for the moſt part drawn off, and had brought over with it at leaſt moſt of the volatile and aromatic oil of the ſeeds. And then increaſing the fire, and changing the receiver, I obtained beſides an empyreumatical ſpirit, and a quantity of aduſt oil; whereof a little floated upon the ſpirit, and the reſt was more heavy, and not eaſily ſeparable from it. And whereas theſe oils were very dark, and ſmelled (as the chymiſts ſpeak) ſo ſtrongly of the fire, that their odour did not betray from what vegetables they had been forced; the other aromatic oil was enriched with the genuine ſmell and taſte of the concrete; and ſpontaneouſly coagulating itſelf into white butter, did manifeſt itſelf to be the true oil of aniſeeds: which concrete I therefore choſe to employ about this experiment, that the difference of theſe oils might be more conſpicuous than it would have been, had I, inſtead of it, diſtilled another vegetable.

I HAD almoſt forgot to take notice, that there is another ſort of bodies, which though not obtained from concretes by diſtillation, many chymiſts are wont to call their ſulphur; not only becauſe ſuch ſubſtances are, for the moſt part, high coloured, (whence they are alſo, and that more properly, called tinctures) as diſſolved ſulphurs are wont to be; but eſpecially becauſe they are, for the moſt part, abſtracted and ſeparated from the reſt of the maſs by ſpirit of wine: which liquor thoſe men ſuppoſing to be ſulphureous, they conclude, that what it works upon, and abſtracts, muſt be a ſulphur alſo. And upon this account they preſume, that they can ſequeſter the ſulphur even of minerals and metals; for which it is known, that they cannot by fire alone ſeparate it. To all this I ſhall anſwer, that if theſe ſequeſtered ſubſtances were indeed the ſulphurs of the bodies, whence they are drawn, there would as well be a great diſparity betwixt chymical ſulphurs obtained by ſpirit of wine, as I have already ſhewn there is betwixt thoſe obtained by diſtillation in the form of oils: which will be evident from hence, that not to urge, that themſelves aſcribe diſtinct virtues to mineral tincture, extolling the tincture of gold againſt ſuch and ſuch diſeaſes; the tincture of antimony, or of its glaſs, againſt others; and the tincture of emerald againſt others; it is plain, that in tinctures drawn from vegetables, if the ſuperfluous ſpirit of wine be diſtilled off, it leaves at the bottom that thicker ſubſtance, which chymiſts uſe to call the extract of the vegetable. And that theſe extracts are endowed with very different qualities, according to the nature of the particular bodies, that afforded them (though I fear ſeldom with ſo much of the ſpecifick virtues, as is wont to be imagined) is freely confeſſed both by phyſicians and chymiſts. But, *Eleutherius*, (ſays *Carneades*) we may here take notice, that the chymiſts do as well in this caſe, as in many others, allow themſelves a licence to abuſe words: for not again to argue from the differing properties of tinctures, that they are not exactly pure and elementary ſulphurs; they would eaſily appear not to be ſo much as ſulphurs, although we ſhould allow chymical oils to deſerve that name. For however in ſome mineral tinctures, the natural fixedneſs of the extracted body does not always ſuffer it to be eaſily further reſoluble into differing ſubſtances; yet in very many extracts drawn from vegetables, it may very eaſily be manifeſted, that the ſpirit of wine has not ſequeſtered the ſulphureous ingredient from the ſaline and mercurial ones, but has diſſolved (for I take it to be a ſolution) the finer parts of the concrete (without making any nice diſtinction of their being perfectly ſulphureous or not) and united itſelf with them into a kind of magiſtery, which conſequently muſt contain ingredients or parts of ſeveral ſorts. For we ſee, that the ſtones, that are rich in vitriol, being often drenched with rain-water, the liquor will then extract a fine and tranſparent ſubſtance coagulable into vitriol; and yet though this vitriol be readily diſſoluble in water, it is not a true elementary ſalt, but, as you know, a body reſoluble into very differing parts, whereof one (as I ſhall have occaſion to tell you anon) is yet of a metalline, and conſequently not of an elementary nature. You may conſider alſo, that common ſulphur is readily diſſoluble in oil of turpentine, though notwithſtanding its name it abounds as well, if not as much, in ſalt as in true ſulphur; witneſs the great quantity of ſaline liquor it affords, being ſet to flame away under a glaſs bell. Nay, I have, which perhaps you will think ſtrange, with the ſame oil of turpentine alone eaſily enough diſſolved crude antimony finely powdered into a blood-red balſam, wherewith perhaps conſiderable things may be performed in ſurgery. And if it were now requiſite, I could tell you of ſome other bodies, (ſuch as perhaps

you would not ſuſpect) that I have been able to work upon with certain chymical oils. But inſtead of digreſſing further, I ſhall make this uſe of the example I have named. That it is not unlikely, but that ſpirit of wine, which by its pungent taſte, and by ſome other qualities, that argue it better, (eſpecially its reducibleneſs, according to *Helmont*, into alcali, and water,) ſeems to be as well of a ſaline as of a ſulphureous nature, may well be ſuppoſed capable of diſſolving ſubſtances, that are not merely elementary ſulphurs, though perhaps they may abound with parts, that are of kin thereunto. For I find, that ſpirit of wine will diſſolve gum lacca, benzoin, and the reſinous parts of jallap, and even of guaiacum; whence we may well ſuſpect, that it may from ſpices, herbs, and other leſs compacted vegetables, extract ſubſtances, that are not perfect ſulphurs, but mixt bodies. And to put it paſt diſpute, there is many a vulgar extract drawn with ſpirit of wine, which committed to diſtillation will afford ſuch differing ſubſtances, as will loudly proclaim it to have been a very compounded body. So that we may juſtly ſuſpect, that even in mineral tinctures it will not always follow, that becauſe a red ſubſtance is drawn from the concrete by ſpirit of wine, that ſubſtance is its true and elementary ſulphur. And though ſome of theſe extracts may perhaps be inflammable; yet, beſides that others are not, and beſides that their being reduced to ſuch minuteneſs of parts may much facilitate their taking fire; beſides this, I ſay, we ſee, that common ſulphur, common oil, gum lac, and many unctuous and reſinous bodies, will flame well enough, though they be of very compounded natures: nay, travellers of unſuſpected credit aſſure us, as a known thing, that in ſome northern countries, where fir-trees and pines abound, the poorer ſort of inhabitants uſe long ſplinters of thoſe reſinous woods to burn inſtead of candles. And as for the redneſs wont to be met with in ſuch ſolutions, I could eaſily ſhew, that it is not neceſſary it ſhould proceed from the ſulphur of the concrete, diſſolved by the ſpirit of wine; if I had leiſure to manifeſt, how much chymiſts are wont to delude themſelves and others, by the ignorance of thoſe other cauſes, upon whoſe account ſpirit of wine and other menſtruums may acquire a red or ſome other high colour. But to return to our chymical oils, ſuppoſing that they were exactly pure; yet I hope they would be, as the beſt ſpirit of wine is, but the more inflammable and deflagrable. And therefore, ſince an oil can be by the fire alone immediately turned into flame, which is ſomething of a very differing nature from it; I ſhall demand, how this oil can be a primogeneal and incorruptible body, as moſt chymiſts would have their principles; ſince it is further reſoluble into flame, which, whether or no it be a portion of the element of fire, as an Ariſtotelian would conclude, is certainly ſomething of a very differing nature from a chymical oil, ſince it burns, and ſhines, and mounts ſwiftly upwards; none of which a chymical oil does, whilſt it continues ſuch. And if it ſhould be objected, that the diſſipated parts of this flaming oil may be caught and collected again into oil or ſulphur; I ſhall demand, what chymiſt appears to have ever done it: and without examining, whether it may not hence be as well ſaid, that ſulphur is but compacted fire, as that fire is but diffuſed ſulphur, I ſhall leave you to conſider, whether it may not hence be argued, that neither fire nor ſulphur are primitive and indeſtructible bodies. And I ſhall further obſerve, that at leaſt it will hence appear, that a portion of matter may, without being compounded with new ingredients, by having the texture and motion of its ſmall parts changed, be eaſily, by the means of the fire, endowed with new qualities, more differing from them it had before, than are thoſe, which ſuffice to diſcriminate the chymiſts principles from one another.

WE are next to conſider, whether in the anatomy of mixt bodies, that, which chymiſts call the mercurial part of them, be uncompounded, or no. But to tell you true, though chymiſts do unanimouſly affirm, that their reſolutions diſcover a principle, which they call mercury, yet I find them to give of it deſcriptions ſo differing, and ſo ænigmatical, that I, who am not aſhamed to confeſs, that I cannot underſtand what is not ſenſe, muſt acknowledge to you, that I know not what to make of them. *Paracelſus* himſelf, and therefore, as you will eaſily believe, many of his followers, does ſomewhere call that mercury, which aſcends upon the burning of wood, as the Peripateticks are wont to take the ſame ſmoke for air; and ſo ſeems to define mercury by volatility, or (if I may coin ſuch a word) effumability. But ſince, in this example, both volatile ſalt and ſulphur make part of the ſmoke, which does indeed conſiſt alſo both of phlegmatick and terrene corpuſcles, this notion is not to be admitted; and I find, that the more ſober chymiſts themſelves diſavow it. Yet to ſhew you, how little of clearneſs we are to expect in the accounts even of later Spagyriſts, be pleaſed to take notice, that *Beguinus*, even in his *Tyrocinium Chymicum*, written for the inſtruction of novices, when he comes to tell us what are meant by the *tria prima*, which for their being principles ought to be defined the more accurately and plainly, gives us this deſcription of mercury; *Mercurius* (ſays he) *eſt liquor ille acidus, permeabilis, penetrabilis, æthereus, ac puriſſimus, à quo omnis nutricatio, ſenſus, motus, vires, colores, ſenectutiſque præproperæ retardatio.* Which words are not ſo much a definition of it, as an encomium: and yet *Quercetanus*, in his deſcription of the ſame principle, adds to theſe divers other epithets. But both of them, to ſkip very many other faults, that may be found with their metaphorical deſcriptions, ſpeak incongruouſly to the chymiſts own principles. For if mercury be an acid liquor, either hermetical philoſophy muſt err in aſcribing all taſtes to ſalt, or elſe mercury muſt not be a principle, but compounded of a ſaline ingredient and ſomewhat elſe. *Libavius*, though he finds great fault with the obſcurity of what the chymiſts write concerning their mercurial principle, does yet

Chym. Tyrocin. lib. 1. cap. 2.

but give us ſuch a negative deſcription of it, as *Sennertus*, how favourable ſoever to the *tria prima*, is not ſatisfied with. And this *Sennertus* himſelf, though the learnedeſt champion for the hypoſtatical principles, does almoſt as frequently, as juſtly, complain of the unſatisfactorineſs of what the chymiſts teach concerning their mercury; and yet he himſelf (but with his wonted modeſty) ſubſtitutes inſtead of the deſcription of *Libavius*, another, which many readers, eſpecially if they be not Peripateticks, will not know what to make of. For ſcarce telling us any more, than that in all bodies, that, which is found beſides ſalt and ſulphur, and the elements, or, as they call them, phlegm and dead earth, is that ſpirit, which, in *Ariſtotle*'s language, may be called οὐσία ἀνάλογος τῶν ἁπλῶν στοιχείων· he ſays that, which I confeſs is not at all ſatisfactory to me, who do not love to ſeem to acquieſce in any man's myſtical doctrines, that I may be thought to underſtand them.

IF (ſays *Eleutherius*) I durſt preſume, that the ſame thing would be thought clear by me, and thoſe, that are fond of ſuch cloudy expreſſions, as you juſtly tax the chymiſts for, I ſhould venture to offer to conſideration, whether or no, ſince the mercurial principle, that ariſes from diſtillation, is unanimouſly aſſerted to be diſtinct from the ſalt and ſulphur of the ſame concrete, that may not be called the mercury of a body, which though it aſcend in diſtillation, as do the phlegm and ſulphur, is neither inſipid like the former, nor inflammable like the latter. And therefore I would ſubſtitute to the too much abuſed name of mercury, the more clear and familiar appellation of ſpirit, which is alſo now very much made uſe of, even by the chymiſts themſelves of our times, though they have not given us ſo diſtinct an explication, as were fit, of what may be called the ſpirit of a mixt body.

I SHOULD not perhaps (ſays *Carneades*) much quarrel with your notion of mercury. But as for the chymiſts, what they can mean, with congruity to their own principles, by the mercury of animals and vegetables, it will not be ſo eaſy to find out; for they aſcribe taſtes only to the ſaline principle, and conſequently would be much put to it to ſhew what liquor it is, in the reſolution of bodies, that not being inſipid, for that they call phlegm, neither is inflammable as oil or ſulphur, nor has any taſte; which, according to them, muſt proceed from a mixture, at leaſt, of ſalt. And if we ſhould take ſpirit in the ſenſe of the word received among modern chymiſts and phyſicians, for any diſtilled liquor, that is neither phlegm nor oil, the appellation would yet appear ambiguous enough. For plainly, that, which firſt aſcends in the diſtillation of wine and fermented liquors, is generally as well by chymiſts as others reputed a ſpirit. And yet pure ſpirit of wine being wholly inflammable, ought, according to them, to be reckoned to the ſulphureous, not the mercurial principle. And among the other liquors, that go under the name of ſpirits, there are divers, which ſeem to belong to the family of ſalts; ſuch as are the ſpirit of nitre, vitriol, ſea-ſalt and others, and even the ſpirit of hartſhorn, being as I have tried, in great part, if not totally, reducible into ſalt and phlegm, may be ſuſpected to be but a volatile ſalt diſguiſed by the phlegm mingled with it into the form of a liquor; however, if this be a ſpirit, it manifeſtly differs very much from that of vinegar, the taſte of the one being acid, and the other ſalt; and their mixture, in caſe they be very pure, ſometimes occaſioning an effervescence like that of thoſe liquors the chymiſts account moſt contrary to one another. And even among thoſe liquors, that ſeem to have a better title, than thoſe hitherto mentioned, to the name of ſpirits, there appears a ſenſible diverſity; for ſpirit of oak, for inſtance, differs from that of tartar, and this from that of box, or of guaiacum. And in ſhort, even theſe ſpirits, as well as other diſtilled liquors, manifeſt a great diſparity betwixt themſelves, either in their actions on our ſenſes, or in their other operations.

AND (continues *Carneades*) beſides this diſparity, that is to be met with among thoſe liquors, that the moderns call ſpirits, and take for ſimilar bodies, what I have formerly told you concerning the ſpirit of box-wood, may let you ſee, that ſome of thoſe liquors not only have qualities very differing from others, but may be further reſolved into ſubſtances differing from one another.

AND ſince many modern chymiſts and other naturaliſts are pleaſed to take the mercurial ſpirit of bodies for the ſame principle, under differing names, I muſt invite you to obſerve, with me, the great difference, that is conſpicuous betwixt all the vegetable and animal ſpirits I have mentioned, and running mercury. I ſpeak not of that, which is commonly ſold in ſhops, that many of themſelves will confeſs to be a mixt body; but of that, which is ſeparated from metals, which by ſome chymiſts, that ſeem more philoſophers than the reſt, and eſpecially by the above mentioned *Claveus*, is (for diſtinction-ſake) called *mercurius corporum*. Now this metalline liquor being one of thoſe three principles, of which mineral bodies are, by Spagyriſts, affirmed to be compoſed, and to be reſoluble into them, the many notorious differences betwixt them and the mercuries, as they call them, of vegetables and animals, will allow me to infer, either that minerals and the other two ſorts of mixt bodies conſiſt not of the ſame elements, or that thoſe principles, whereinto minerals are immediately reſolved, which chymiſts with great oſtentation ſhew us as the true principles of them, are but ſecundary principles, or mixts of a peculiar ſort, which muſt be themſelves reduced to a very differing form, to be of the ſame kind with vegetable and animal liquors.

BUT this is not all; for though I formerly told you, how little credit there is to be given to the chymical proceſſes, commonly to be met with, of extracting the mercuries of metals, yet I will now add, that ſuppoſing, that the more judicious of them do not untruly affirm, that they have really drawn true and running

mercury from ſeveral metals, (which I wiſh they had clearly taught us how to do alſo,) yet it may be ſtill doubted, whether ſuch extracted mercuries do not as well differ from common quickſilver, and from one another, as from the mercuries of vegetables and animals. *Claveus* *, in his apology, ſpeaking of ſome experiments, whereby metalline mercuries may be fixt into the nobler metals, adds, that he ſpake of the mercuries drawn from metals; becauſe common quickſilver, by reaſon of its exceſſive coldneſs and moiſture, is unfit for that particular kind of operation; for which, though a few lines before he preſcribes in general the mercuries of metalline bodies, yet he chiefly commends that drawn by art from ſilver. And elſewhere, in the ſame book, he tells us, that he himſelf tried, that by bare coction the quickſilver of tin or pewter (*argentum vivum ex ſtanno prolicitum*) may, by an efficient cauſe, (as he ſpeaks) be turned into pure gold. And the experienced *Alexander van Suchten*, ſomewhere tells us, that by a way he intimates may be made a mercury of copper, not of the ſilver colour of other mercuries, but green; to which I ſhall add, that an eminent perſon, whoſe name his travels and learned writings have made famous, lately aſſured me, that he had more than once ſeen the mercury of lead (which whatever authors promiſe, you will find it very difficult to make, at leaſt in any conſiderable quantity) fixt into perfect gold. And being by me demanded, whether or no any other mercury would not as well have been changed by the ſame operations, he aſſured me of the negative.

AND ſince I am fallen upon the mention of the mercuries of metals, you will, perhaps, expect, (*Eleutherius*) that I ſhould ſay ſomething of their two other principles; but I muſt freely confeſs to you, that what diſparity there may be between the ſalts and ſulphurs of metals or other minerals, I am not myſelf experienced enough in the ſeparations and examens of them, to venture to determine: (for, as for the ſalts of metals, I formerly repreſented it as a thing much to be queſtioned, whether they have any at all.) And for the proceſſes of ſeparation I find in authors, if they were (what many of them are not) ſucceſsfully practicable, as I noted above, yet they are to be performed by the aſſiſtance of other bodies, ſo hardly, if upon any terms at all, ſeparable from them, that it is very difficult to give the ſeparated principles all their due, and no more. But the ſulphur of antimony, which is vehemently vomitive, and the ſtrongly-ſcented anodyne ſulphur of vitriol, inclines me to think, that not only mineral ſulphurs differ from vegetable ones, but alſo from one another, retaining much of the nature of their concretes. The ſalts of metals, and of ſome ſort of minerals, you will eaſily gueſs (by the doubts I formerly expreſſed, whether metals have any ſalt at all) that I have not been ſo happy as yet to ſee, perhaps not for want of curioſity. But if *Paracelſus* did always write ſo conſentaneouſly to himſelf, that his opinion were confidently to be collected from every place of his writings, where he ſeems to expreſs it, I might ſafely take upon me to tell you, that he both countenances in general, what I have delivered in my fourth main conſideration, and in particular warrants me to ſuſpect, that there may be a difference in metalline and mineral ſalts, as well as we find it in thoſe of other bodies. For, *Sulphur* (ſays he) *aliud in auro, aliud in argento, aliud in ferro, aliud in plumbo, ſtanno, &c. ſic aliud in ſaphyro, aliud in ſmaragdo, aliud in rubino, chryſolitho, amethyſto, magnete, &c. item aliud in lapidibus, ſilice, ſalibus, fontibus, &c. Nec vero tot ſulphura tantum, ſed & totidem ſalia; ſal aliud in metallis, aliud in gemmis, aliud in lapidibus, aliud in ſalibus, aliud in vitriolo, aliud in alumine: ſimilis etiam mercurii eſt ratio. Alius in metallis, alius in gemmis, &c. Ita ut unicuique ſpeciei ſuus peculiaris mercurius ſit. Et tamen res ſaltem tres ſunt; una eſſentia eſt ſulphur; una eſt ſal; una eſt mercurius. Addo quod & ſpecialius adhuc ſingula dividantur; aurum enim non unum, ſed multiplex, ut & non unum pyrum, pomum, ſed idem multiplex, totidem etiam ſulphura auri, ſalia auri, mercurii auri; idem competit etiam metallis & gemmis; ut quot ſaphyri præſtantiores, leviores, &c. tot etiam ſaphyrica ſulphura, ſaphyrica ſalia, ſaphyrici mercurii, &c. Idem verum etiam eſt de turconibus & gemmis aliis univerſis.* From which paſſage, *Eleutherius*, I ſuppoſe you will think I might without raſhneſs conclude, either that my opinion is favoured by that of *Paracelſus*, or that *Paracelſus* his opinion was not always the ſame. But becauſe in divers other places of his writings he ſeems to talk at a differing rate of the three principles and the four elements, I ſhall content myſelf to infer from the alledged paſſage, that if his doctrine be not conſiſtent with that part of mine, which it is brought to countenance, it is very difficult to know what his opinion concerning ſalt, ſulphur, and mercury, was; and that conſequently we had reaſon, about the beginning of our conferences, to decline taking upon us, either to examine or oppoſe it.

Paracelſ. de Mineral. Tract. 1. pag. 141.

I KNOW not whether I ſhould on this occaſion add, that thoſe very bodies, the chymiſts call phlegm and earth, do yet recede from an elementary ſimplicity. That common earth and water frequently do ſo, notwithſtanding the received contrary opinion, is not denied by the more wary of the modern Peripateticks themſelves: and certainly moſt earths are much leſs ſimple bodies than is commonly imagined even by chymiſts, who do not ſo conſiderately, to preſcribe and employ earths promiſcuouſly in thoſe diſtillations, that require the mixture of ſome *caput mortuum*, to hinder the flowing together of the matter, and to retain its groſſer parts. For I have found ſome earths to yield, by diſtillation, a liquor very far from being inodorous or inſipid; and it is a known obſervation, that moſt kinds of fat earth kept covered from the rain, and hindered from ſpending themſelves

* *Dixi autem de argento vivo à metallis prolicito, quod vulgare ob nimiam frigiditatem & humiditatem nimium concoctioni eſt contumax, nec ab auro ſolum alteratio coerceri poteſt.* Gaſt. Clave. in Apol.

themſelves in the production of vegetables, will in time become impregnated with ſalt-petre.

BUT I muſt remember, that the water and earths I ought here to ſpeak of, are ſuch as are ſeparated from mixt bodies by the fire; and therefore to reſtrain my diſcourſe to ſuch, I ſhall tell you, that we ſee the phlegm of vitriol (for inſtance) is a very effectual remedy againſt burns; and I know a very famous and experienced phyſician, whoſe unſuſpected ſecret (himſelf confeſſed to me) it is, for the diſcuſſing of hard and obſtinate tumours. The phlegm of vinegar, though drawn exceeding leiſurely in a digeſting furnace, I have purpoſely made trial of; and ſometimes found it able to draw, though ſlowly, a ſaccharine ſweetneſs out of lead; and as I remember, by long digeſtion, I diſſolved corals in it. The phlegm of the ſugar of Saturn is ſaid to have very peculiar properties. Divers eminent chymiſts teach, that it will diſſolve pearls, which being precipitated by the ſpirit of the ſame concrete, are thereby (as they ſay) rendered volatile; which has been confirmed to me, upon his own obſervation, by a perſon of great veracity. The phlegm of wine, and indeed divers other liquors, that are indiſcriminately condemned to be caſt away as phlegm, are endowed with qualities, that make them differ both from meer water, and from each other. And whereas the chymiſts are pleaſed to call the *caput mortuum* of what they have diſtilled (after they have, by affuſion of water, drawn away its ſalt) *terra damnata*, or earth, it may be doubted, whether or no thoſe earths are all of them perfectly alike; and it is ſcarce to be doubted, but that there are ſome of them, which remain yet unreduced to an elementary nature. The aſhes of wood, deprived of all the ſalt, and bone-aſhes, or calcined hartſhorn, which refiners chooſe to make teſts of, as freeſt from ſalt, ſeem unlike: and he that ſhall compare either of theſe inſipid aſhes to lime, and much more to the calx of talc, (though by the affuſion of water they be exquiſitely dulcified) will perhaps ſee cauſe to think them things of a ſomewhat different nature. And it is evident in colcothar, that the exacteſt calcination, followed by an exquiſite dulcification, does not always reduce the remaining body into elementary earth; for after the ſalt or vitriol (if the calcination have been too faint) is drawn out of the colcothar, the reſidue is not earth, but a mixt body, rich in medical virtues (as experience has informed me) and which *Angelus Sala* affirms to be partly reducible into malleable copper: which I judge very probable; for though, when I was making experiments upon colcothar, I was deſtitute of a furnace capable of giving a heat intenſe enough to bring ſuch a calx to fuſion; yet having conjectured, that if colcothar abounded with that metal, aqua fortis would find it out there, I put ſome dulcified colcothar into that menſtruum, and found the liquor, according to my expectation, preſently coloured as highly, as if it had been an ordinary ſolution of copper.

THE SCEPTICAL CHYMIST:

PART V.

HERE *Carneades* making a pauſe, I muſt not deny (ſays his friend to him) that I think you have ſufficiently proved, that theſe diſtinct ſubſtances, which chymiſts are wont to obtain from mixt bodies, by their vulgar diſtillation, are not pure and ſimple enough to deſerve, in rigour of ſpeaking, the name of elements, or principles. But I ſuppoſe you have heard, that there are ſome modern Spagyriſts, who give out, that they can, by further and more ſkilful purifications, ſo reduce the ſeparated ingredients of mixt bodies to an elementary ſimplicity, that the oils (for inſtance) extracted from all mixts ſhall as perfectly reſemble one another, as the drops of water do.

IF you remember (replies *Carneades*) that at the beginning of our conference with *Philoponus*, I declared to him before the reſt of the company, that I would not engage myſelf at preſent to do any more, than examine the uſual proofs alledged by chymiſts, for the vulgar doctrine of their three hypoſtatical principles; you will eaſily perceive, that I am not obliged to make anſwer to what you newly propoſed; and that it rather grants, than diſproves what I have been contending for: ſince by pretending to make ſo great a change in the reputed principles, that diſtillation affords the common Spagyriſts, it is plainly enough pre-ſuppoſed, that before ſuch artificial depurations be made, the ſubſtances to be made more ſimple were not yet ſimple enough to be looked upon as elementary: wherefore in caſe the artiſts you ſpeak of could perform what they give out they can, yet I ſhould not need to be aſhamed of having queſtioned the vulgar opinion touching the *tria prima*. And as to the thing it ſelf, I ſhall freely acknowledge to you, that I love not to be forward in determining things to be impoſſible, till I know and have conſidered the means, by which they are propoſed

to

to be effected. And therefore I ſhall not peremptorily deny, either the poſſibility of what theſe artiſts promiſe, or my aſſent to any juſt inference, however deſtructive to my conjectures, that may be drawn from their performances. But give me leave to tell you withall, that becauſe ſuch promiſes are wont (as experience has more than once informed me) to be much more eaſily made, than made good by chymiſts, I muſt with-hold my belief from their aſſertions, till their experiments exact it; and muſt not be ſo eaſy as to expect before-hand an unlikely thing, upon ſtronger inducements than are yet given me: beſides that I have not yet found by what I have heard of theſe artiſts, that though they pretend to bring the ſeveral ſubſtances, into which the fire has divided the concrete, to an exquiſite ſimplicity, they pretend alſo to be able by the fire to divide all concretes, minerals, and others, into the ſame number of diſtinct ſubſtances. And in the mean time I muſt think it improbable, that they can either truly ſeparate as many differing bodies from gold (for inſtance) or oſtiocolla, as we can do from wine, or vitriol; or that the mercury (for example) of gold or Saturn would be perfectly of the ſame nature with that of hartſhorn; and that the ſulphur of antimony would be but numerically different from the diſtilled butter or oil of roſes.

BUT ſuppoſe (ſays *Eleutherius*) that you ſhould meet with chymiſts, who would allow you to take in earth and water into the number of the principles of mixt bodies; and being alſo content to change the ambiguous name of mercury for that more intelligible one of ſpirit, ſhould conſequently make the principles or compound bodies to be five; would you not think it ſomething hard to reject ſo plauſible an opinion, only becauſe the five ſubſtances, into which the fire divides mixt bodies, are not exactly pure, and homogeneous? For my part (continues *Eleutherius*) I cannot but think it ſomewhat ſtrange, in caſe this opinion be not true, that it ſhould fall out ſo luckily, that ſo great a variety of bodies ſhould be analyzed by the fire into juſt five diſtinct ſubſtances; which ſo little differing from the bodies, that bear thoſe names, may ſo plauſibly be called oil, ſpirit, ſalt, water, and earth.

THE opinion you now propoſe (anſwers *Carneades*) being another than that I was engaged to examine, it is not requiſite for me to debate at this preſent; nor ſhould I have leiſure to do it throughly. Wherefore, I ſhall only tell you in general, that though I think this opinion in ſome reſpects more defenſible than that of the vulgar chymiſts; yet you may eaſily enough learn from the paſt diſcourſe, what may be thought of it: ſince many of the objections made againſt the vulgar doctrine of the chymiſts ſeem, without much alteration, employable againſt this hypotheſis alſo. For, beſides that this doctrine does, as well as the other, take it for granted, (what is not eaſy to be proved) that the fire is the true and adequate analyzer of bodies, and that all the diſtinct ſubſtances obtainable from a mixt body by the fire, were ſo pre-exiſtent in it, that they were but extricated from each other by the analyſis; beſides that this opinion too aſcribes to the productions of the fire an elementary ſimplicity, which I have ſhewn not to belong to them; and beſides that this doctrine is liable to ſome of the other difficulties, wherewith that of the *tria prima* is incumbered: beſides all this, I ſay, this quinary number of elements, (if you pardon the expreſſion) ought at leaſt to have been reſtrained to the generality of animal and vegetable bodies, ſince not only among theſe there are ſome bodies, (as I formerly argued) which, for aught yet has been made to appear, do conſiſt, either of fewer or more ſimilar ſubſtances than preciſely five. But in the mineral kingdom, there is ſcarce one concrete, that has been evinced to be adequately diviſible into ſuch five principles or elements, and neither more nor leſs, as this opinion would have every mixt body to conſiſt of.

AND this very thing (continues *Carneades*) may ſerve to take away or leſſen your wonder, that juſt ſo many bodies as five ſhould be found upon the reſolution of concretes. For ſince we find not, that the fire can make any ſuch analyſis (into five elements) of metals and other mineral bodies, whoſe texture is more ſtrong and permanent, it remains, that the five ſubſtances under conſideration be obtained from vegetable and animal bodies, which (probably by reaſon of their looſer contexture) are capable of being diſtilled. And as to ſuch bodies, it is natural enough, that, whether we ſuppoſe, that there are, or are not, preciſely five elements, there ſhould ordinarily occur in the diſſipated parts, a five-fold diverſity of ſcheme, (if I may ſo ſpeak.) For, if the parts do not remain all fixed, as in gold, calcined talc, *&c.* nor all aſcend, as in the ſublimation of brimſtone, camphire, *&c.* but after their diſſipation do aſſociate themſelves into new ſchemes of matter; it is very likely, that they will, by the fire, be divided into fixed and volatile; (I mean, in reference to that degree of heat, by which they are diſtilled) and thoſe volatile parts will, for the moſt part, aſcend either in a dry form, which chymiſts are pleaſed to call, if they be taſteleſs, flowers; if ſapid, volatile ſalt; or in a liquid form. And this liquor muſt be either inflammable, and ſo paſs for oil; or not inflammable, and yet ſubtile and pungent, which may be called ſpirit; or elſe ſtrengthleſs or inſipid, which may be named phlegm, or water. And as for the ſixth part, or *caput mortuum*, it will moſt commonly conſiſt of corpuſcles, partly ſoluble in water, or ſapid, (eſpecially if the ſaline parts were not ſo volatile, as to fly away before) which make up its fixt ſalt; and partly inſoluble and inſipid, which therefore ſeems to challenge the name of earth. But although upon this ground one might eaſily enough have foretold, that the differing ſubſtances obtained from a perfectly mixt body by the fire would for the moſt part be reducible to the five newly-mentioned ſtates of matter; yet it will not preſently follow, that theſe five diſtinct ſubſtances were ſimple and

primogeneal bodies, ſo pre-exiſtent in the concrete, that the fire does but take them aſunder. Beſides that it does not appear, that all mixt bodies, (witneſs, gold, ſilver, mercury, *&c.*) nay, nor perhaps all vegetables, which may appear by what we ſaid above of camphire, benzoin, *&c.* are reſoluble by fire into juſt ſuch differing ſchemes of matter. Nor will the experiments, formerly alledged, permit us to look upon theſe ſeparated ſubſtances as elementary or uncompounded. Neither will it be a ſufficient argument of their being bodies, that deſerve the names, which chymiſts are pleaſed to give them, that they have an analogy in point of conſiſtence, or either volatility or fixedneſs, or elſe ſome other obvious quality, with the ſuppoſed principles, whoſe names are aſcribed to them. For, as I told you above, notwithſtanding this reſemblance in ſome one quality, there may be ſuch a diſparity in others, as may be more fit to give them differing appellations, than the reſemblance is to give them one and the ſame. And indeed it ſeems but ſomewhat a groſs way of judging of the nature of bodies, to conclude without ſcruple, that thoſe muſt be of the ſame nature, that agree in ſome ſuch general quality, as fluidity, dryneſs, volatility, and the like: ſince each of thoſe qualities, or ſtates of matter, may comprehend a great variety of bodies, otherwiſe of a very differing nature; as we may ſee in the calxes of gold, of vitriol, and of Venetian talc, compared with common aſhes; which yet are very dry, and fixed by the vehemence of the fire, as well as they. And as we may likewiſe gather from what I have formerly obſerved, touching the ſpirit of box-wood, which though a volatile, ſapid, and not inflammable liquor, as well as the ſpirits of hartſhorn, of blood and others, (and therefore has been hitherto called the ſpirit, and eſteemed for one of the principles of the wood that affords it) may yet, as I told you, be ſubdivided into two liquors, differing from one another, and one of them at leaſt, from the generality of other chymical ſpirits.

BUT you may your ſelf, if you pleaſe, (purſues *Carneades*) accommodate to the hypotheſis you propoſed, what other particulars you ſhall think applicable to it in the foregoing diſcourſe. For I think it unſeaſonable for me to meddle now any further with a controverſy, which, ſince it does not now belong to me, leaves me at liberty to take my own time to declare my ſelf about it.

ELEUTHERIUS perceiving, that *Carneades* was ſomewhat unwilling to ſpend any more time upon the debate of this opinion, and having perhaps ſome thoughts of taking hence a riſe to make him diſcourſe it more fully another time, thought not fit as then to make any further mention to him of the propoſed opinion; but told him,

I PRESUME I need not mind you, *Carneades*, that both the patrons of the ternary number of principles, and thoſe that would have five elements, endeavour to back their experiments with a ſpecious reaſon or two; and eſpecially ſome of thoſe embracers of the opinion laſt named (whom I have converſed with, and found them learned men) aſſign this reaſon of the neceſſity of five diſtinct elements; that otherwiſe mixt bodies could not be ſo compounded and tempered, as to obtain a due conſiſtence and competent duration. For ſalt (ſay they) is the baſis of ſolidity, and permanency in compound bodies, without which the other four elements might indeed be variouſly and looſely blended together, but would remain incompacted; but that ſalt might be diſſolved into minute parts, and conveyed to the other ſubſtances to be compacted by it; and with it, there is a neceſſity of water. And that the mixture may not be too hard and brittle, a ſulphureous or oily principle muſt intervene, to make the maſs more tenacious: to this a mercurial ſpirit muſt be ſuperadded; which by its activity may for a while permeate, and, as it were, leaven the whole maſs, and thereby promote the more exquiſite mixture and incorporation of the ingredients. To all which, laſtly, a portion of earth muſt be added, which by its dryneſs and poroſity may ſoak up part of that water, wherein the ſalt was diſſolved, and eminently concur with the other ingredients to give the whole body the requiſite conſiſtence.

I PERCEIVE (ſays *Carneades* ſmiling) that if it be true, as it was lately noted from the proverb, *That good wits have bad memories*, you have that title, as well as a better, to a place among the good wits. For you have already more than once forgot, that I declared to you, that I would at this conference examine only the experiments of my adverſaries, not their ſpeculative reaſons. Yet it is not (ſubjoins *Carneades*) for fear of meddling with the argument you have propoſed, that I decline the examining it at preſent. For if when we are more at leiſure, you ſhall have a mind, that we may ſolemnly conſider of it together; I am confident we ſhall ſcarce find it inſoluble. And in the mean time we may obſerve, that ſuch a way of arguing may, it ſeems, be ſpeciouſly accommodated to differing hypotheſes. For I find, that *Beguinus*, and other aſſertors of the *tria prima*, pretend to make out by ſuch a way the requiſiteneſs of their ſalt, ſulphur and mercury, to conſtitute mixt bodies, without taking notice of any neceſſity of an addition of water and earth.

AND indeed neither ſort of chymiſts ſeem to have duly conſidered, how great variety there is in the textures and conſiſtences of compound bodies; and how little the conſiſtence and duration of many of them ſeem to accommodate and be explicable by the propoſed notion. And not to mention thoſe almoſt incorruptible ſubſtances obtainable by the fire, which I have proved to be ſomewhat compounded, and which the chymiſts will readily grant not to be perfectly mixt bodies; (not to mention theſe, I ſay) if you will but recall to mind ſome of thoſe experiments, whereby I ſhewed you, that out of common water only mixt bodies (and even living ones) of very differing conſiſtences, and reſoluble by fire into as many principles as other bodies acknowledged to be perfectly mixt, may be produced; if you do

this, I ſay, you will not, I ſuppoſe, be averſe from believing, that nature, by a convenient diſpoſition of the minute parts of a portion of matter, may contrive bodies durable enough, and of this, or that, or the other conſiſtence, without being obliged to make uſe of all, much leſs of any determinate quantity of each of the five elements, or of the three principles to compound ſuch bodies of. And I have (purſues *Carneades*) ſomething wondered, chymiſts ſhould not conſider, that there is ſcarce any body in nature ſo permanent and indiſſoluble as glaſs; which yet themſelves teach us may be made of bare aſhes, brought to fuſion by the meer violence of the fire; ſo that, ſince aſhes are granted to conſiſt but of pure ſalt and ſimple earth, ſequeſtered from all the other principles or elements, they muſt acknowledge, that even art it ſelf can of two elements only, or if you pleaſe, one principle and one element, compound a body more durable than almoſt any in the world. Which being undeniable, how will they prove, that nature cannot compound mixt bodies, and even durable ones, under all the five elements or material principles?

BUT to inſiſt any longer on this occaſional diſquiſition, touching their opinion, that would eſtabliſh five elements, were to remember as little as you did before, that the debate of this matter is no part of my firſt undertaking; and conſequently, that I have already ſpent time enough in what I look back upon but as a digreſſion, or at beſt an excurſion.

AND thus, *Eleutherius*, (ſays *Carneades*) having at length gone through the four conſiderations I propoſed to diſcourſe unto you, I hold it not unfit, for fear my having inſiſted ſo long on each of them may have made you forget their ſeries, briefly to repeat them by telling you, that

SINCE, in the firſt place, it may juſtly be doubted, whether or no the fire be, as chymiſts ſuppoſe it, the genuine and univerſal reſolver of mixt bodies;

SINCE we may doubt, in the next place, whether or no all the diſtinct ſubſtances, that may be obtained from a mixt body by the fire, were pre-exiſtent there, in the forms, in which they were ſeparated from it;

SINCE alſo, though we ſhould grant the ſubſtances ſeparable from mixt bodies by the fire, to have been their component ingredients, yet the number of ſuch ſubſtances does not appear the ſame in all mixt bodies; ſome of them being reſoluble into more differing ſubſtances than three, and others not being reſoluble into ſo many as three;

AND ſince, laſtly, thoſe very ſubſtances, that are thus ſeparated, are not, for the moſt part, pure and elementary bodies, but new kinds of mixts;

SINCE, I ſay, theſe things are ſo, I hope you will allow me to infer, that the vulgar experiments (I might perchance have added, the arguments too) wont to be alledged by chymiſts to prove, that their three hypoſtatical principles do adequately compoſe all mixt bodies, are not ſo demonſtrative, as to induce a wary perſon to acquieſce in their doctrine, which, till they explain and prove it better, will, by its perplexing darkneſs, be more apt to puzzle than ſatisfy conſidering men, and will to them appear incumbered with no ſmall difficulties.

AND from what has been hitherto deduced (continues *Carneades*) we may learn, what to judge of the common practice of thoſe chymiſts, who, becauſe they have found, that divers compound bodies (for it will not hold in all) can be reſolved into, or rather can be brought to afford two or three differing ſubſtances more than the foot and aſhes, whereinto the naked fire commonly divides them in our chimneys, cry up their own ſect for the invention of a new philoſophy; ſome of them, as *Helmont*, *&c.* ſtyling themſelves philoſophers by the fire; and the moſt part not only aſcribing, but, as far as in them lies, engroſſing to thoſe of their ſect the title of Philoſophers.

BUT alas, how narrow is this philoſophy, that reaches but to ſome of thoſe compound bodies, which we find but upon, or in the cruſt or outſide of our terreſtrial globe, which is it ſelf but a point in compariſon of the vaſt extended univerſe, of whoſe other and greater parts the doctrine of the *tria prima* does not give us an account! For what does it teach us, either of the nature of the ſun, which aſtronomers affirm to be eight-ſcore and odd times bigger than the whole earth? or of that of thoſe numerous fixt ſtars, which, for aught we know, would very few, if any of them, appear inferiour in bulk and brightneſs to the ſun, if they were as near us as he? What does the knowing that ſalt, ſulphur and mercury, are the principles of mixt bodies, inform us of the nature of that vaſt, fluid, and ætherial ſubſtance, that ſeems to make up the interſtellar, and conſequently much the greateſt part of the world? For as for the opinion commonly aſcribed to *Paracelſus*, as if he would have not only the four Peripatetick elements, but even the celeſtial parts of the univerſe, to conſiſt of his three principles, ſince the modern chymiſts themſelves have not thought ſo groundleſs a conceit worth their owning, I ſhall not think it worth my confuting.

BUT I ſhould, perchance, forgive the hypotheſis I have been all this while examining, if, though it reaches but to a very little part of the world, it did at leaſt give us a ſatisfactory account of thoſe things, to which it is ſaid to reach. But I find not, that it gives us any other than a very imperfect information even about mixt bodies themſelves: for how will the knowledge of the *tria prima* diſcover to us the reaſon, why the load-ſtone draws a needle, and diſpoſes it to reſpect the poles, and yet ſeldom preciſely points at them? How will this hypotheſis teach us, how a chick is formed in the egg, or how the ſeminal principles of mint, pompions, and other vegetables, that I mentioned to you above, can faſhion water into various plants, each of them endowed with its peculiar and determinate ſhape, and with divers ſpecifick and diſcriminating qualities? How does this hypotheſis ſhew us, how much ſalt, how much ſulphur,

and

and how much mercury muſt be taken to make a chick or a pompion? And if we know that, what principle is it, that manages theſe ingredients, and contrives (for inſtance) ſuch liquors, as the white and yolk of an egg into ſuch a variety of textures, as is requiſite to faſhion the bones, veins, arteries, nerves, tendons, feathers, blood, and other parts of a chick? and not only to faſhion each limb, but to connect them all together, after that manner, that is moſt congruous to the perfection of the animal, which is to conſiſt of them? For to ſay, that ſome more fine and ſubtile part of either, or all the hypoſtatical principles is the director in all this buſineſs, and the architect of all this elaborate ſtructure, is to give one occaſion to demand again, what proportion and way of mixture of the *tria prima* afforded this architectonick ſpirit, and what agent made ſo ſkilful and happy a mixture? And the anſwer to this queſtion, if the chymiſts will keep themſelves within their three principles, will be liable to the ſame inconvenience, that the anſwer to the former was. And if it were not to intrench upon the theme of a friend of ours here preſent, I could eaſily proſecute the imperfections of the vulgar chymiſts philoſophy, and ſhew you, that by going about to explicate by their three principles, I ſay not, all the abſtruſe properties of mixt bodies, but even ſuch obvious and more familiar phænomena as fluidity and firmneſs, the colours and figures of ſtones, minerals, and other compound bodies, the nutrition of either plants or animals, the gravity of gold or quickſilver compared with wine or ſpirit of wine; by attempting, I ſay, to render a reaſon of theſe (to omit a thouſand others as difficult to account for) from any proportion of the three ſimple ingredients, chymiſts will be much more likely to diſcredit themſelves and their hypotheſis, than ſatisfy an intelligent inquirer after truth.

BUT (interpoſes *Eleutherius*) this objection ſeems no more than may be made againſt the four Peripatetick elements; and indeed almoſt againſt any other hypotheſis, that pretends by any determinate number of material ingredients to render a reaſon of the phænomena of nature. And as for the uſe of the chymical doctrine of the three principles, I ſuppoſe you need not be told by me, that the great champion of it, the learned *Sennertus*, aſſigns this noble uſe of the *tria prima*, that from them, as the neareſt and moſt proper principles, may be deduced and demonſtrated the properties, which are in mixt bodies, and which cannot be proximately (as they ſpeak) deduced from the elements. And this, ſays he, is chiefly apparent, when we inquire into the properties and faculties of medicines. And I know (continues *Eleutherius*) that the perſon you have aſſumed, of an opponent of the hermetick doctrine, will not ſo far prevail againſt your native and wonted equity, as to keep you from acknowledging, that philoſophy is much beholden to the notions and diſcoveries of chymiſts.

Senn. *de Conſ. & Diſſen.* p. 165.

IF the chymiſts you ſpeak of (replies *Carneades*) had been ſo modeſt, or ſo diſcreet, as to propoſe their opinion of the *tria prima*, but as a notion uſeful among others, to increaſe human knowledge, they had deſerved more of our thanks, and leſs of our oppoſition: but ſince the thing, that they pretend, is not ſo much to contribute a notion toward the improvement of philoſophy, as to make this notion (attended by a few leſs conſiderable ones) paſs for a new philoſophy itſelf; nay, ſince they boaſt ſo much of this fancy of theirs, that the famous *Quercetanus* ſcruples not to write, that if his moſt certain doctrine of the three principles were ſufficiently learned, examined, and cultivated, it would eaſily diſpel all the darkneſs, that benights our minds, and bring in a clear light, that would remove all difficulties; this ſchool affording theorems and axioms irrefragable, and to be admitted without diſpute by impartial judges, and ſo uſeful withal, as to exempt us from the neceſſity of having recourſe, for want of the knowledge of cauſes, to that ſanctuary of the ignorant, occult qualities: ſince I ſay, this domeſtick notion of the chymiſts is ſo much overvalued by them, I cannot think it unfit, they ſhould be made ſenſible of their miſtake; and be admoniſhed to take in more fruitful and comprehenſive principles, if they mean to give us an account of the phænomena of nature; and not confine themſelves, and (as far as they can) others, to ſuch narrow principles, as I fear will ſcarce enable them to give an account (I mean an intelligible one) of the tenth part (I ſay not) of all the phænomena of nature; but even of all ſuch, as by the Leucippian, or ſome of the other ſorts of principles, may be plauſibly enough explicated. And though I be not unwilling to grant, that the incompetency I impute to the chymical hypotheſis is but the ſame, which may be objected againſt that of the four elements, and divers other doctrines that have been maintained by learned men; yet ſince it is the chymical hypotheſis only, which I am now examining, I ſee not why, if what I impute to it be a real inconvenience, either it ſhould ceaſe to be ſo, or I ſhould ſcruple to object it, becauſe other theories are liable thereunto, as well as the hermetical. For I know not, why a truth ſhould be thought leſs a truth for the being fit to overthrow variety of errors.

I AM obliged to you (continues *Carneades*, a little ſmiling) for the favourable opinion you are pleaſed to expreſs of my equity, if there be no deſign in it. But I need not be tempted by an artifice, or invited by a compliment, to acknowledge the great ſervice, that the labours of chymiſts have done the lovers of uſeful learning; nor even, on this occaſion, ſhall their arrogance hinder my gratitude. But ſince we are as well examining the truth of their doctrine, as the merit of their induſtry, I muſt, in order to the inveſtigation of the firſt, continue a reply, to talk at the rate of the part I have aſſumed; and tell you, that when I acknowledge the uſefulneſs of the labours of Spagyriſts to natural philoſophy, I do it upon the ſcore of their experiments, not upon that of their ſpeculations; for it ſeems to me, that their writings, as their furnaces, afford as well

ſmoke

ſmoke as light; and do little leſs obſcure ſome ſubjects, than they illuſtrate others. And though I am unwilling to deny, that it is difficult for a man to be an accompliſhed naturaliſt, that is a ſtranger to chymiſtry; yet I look upon the common operations and practices of chymiſts, almoſt as I do on the letters of the alphabet, without whoſe knowledge it is very hard for a man to become a philoſopher; and yet that knowledge is very far from being ſufficient to make him one.

BUT (ſays *Carneades*, reſuming a more ſerious look) to conſider a little more particularly what you alledge in favour of the chymical doctrine of the *tria prima*, though I ſhall readily acknowledge it not to be unuſeful, and that the deviſers and embracers of it have done the commonwealth of learning ſome ſervice, by helping to deſtroy that exceſſive eſteem, or rather veneration, wherewith the doctrine of the four elements was almoſt as generally, as undeſervedly entertained; yet what has been alledged concerning the uſefulneſs of the *tria prima*, ſeems to me liable to no contemptible difficulties.

AND firſt, as for the very way of probation, which the more learned and more ſober champions of the chymical cauſe employed to evince the chymical principles in mixt bodies, it ſeems to me to be far enough from being convincing. This grand and leading argument, your *Sennertus* himſelf, who lays great weight upon it, and tells us, that the moſt learned philoſophers employ this way of reaſoning to prove the moſt important things, propoſes thus: *Ubicunque* (ſays he) *pluribus eædem affectiones & qualitates inſunt, per commune quoddam principium inſint neceſſe eſt, ſicut omnia ſunt gravia propter terram, calida propter ignem. At colores, odores, ſapores, eſſe φλογιςὸν, & ſimilia alia, mineralibus, metallis, gemmis, lapidibus, plantis, animalibus inſunt. Ergo per commune aliquod principium & ſubjectum inſunt. At tale principium non ſunt elementa. Nullam enim habent ad tales qualitates producendas potentiam. Ergo alia principia, unde fluant, inquirenda ſunt.*

IN the recital of this argument, (ſays *Carneades*) I therefore thought fit to retain the language, wherein the author propoſes it, that I might alſo retain the propriety of ſome Latin terms, to which I do not readily remember any that fully anſwer in Engliſh. But as for the argumentation itſelf, it is built upon a precarious ſuppoſition, that ſeems to me neither demonſtrable nor true; for how does it appear, that where the ſame quality is to be met with in many bodies, it muſt belong to them upon the account of ſome one body whereof they all partake? (for that the major of our author's argument is to be underſtood of the material ingredients of bodies, appears by the inſtances of earth and fire he annexes to explain it.) For to begin with that very example, which he is pleaſed to alledge for himſelf; how can he prove, that the gravity of all bodies proceeds from what they participate of the element of earth, ſince we ſee, that not only common water, but the more pure diſtilled rain-water is heavy; and quickſilver is much heavier than earth itſelf, though none of my adverſaries has yet proved, that it contains any of that element. And I the rather make uſe of this example of quickſilver, becauſe I ſee not how the aſſertors of the elements will give any better account of it than the chymiſts. For if it be demanded, how it comes to be fluid, they will anſwer, that it participates much of the nature of water. And indeed, according to them, water may be the predominant element in it, ſince we ſee, that ſeveral bodies, which by diſtillation afford liquors, that weigh more than their *caput mortuum*, do not yet conſiſt of liquor enough to be fluid. Yet if it be demanded, how quickſilver comes to be ſo heavy, then it is replied, that it is by reaſon of the earth, that abounds in it; but ſince, according to them, it muſt conſiſt alſo of air, and partly of fire, which they affirm to be light elements, how comes it, that it ſhould be ſo much heavier than earth of the ſame bulk, though to fill up the poroſities and other cavities it be made up into a maſs or paſte with water, which it ſelf they allow to be a heavy element. But to return to our Spagyriſts, we ſee, that chymical oils and fixt ſalts, though never ſo exquiſitely purified and freed from terreſtrial parts, do yet remain ponderous enough. And experience has informed me, that a pound, (for inſtance) of ſome of the heavieſt woods, as guaiacum, that will ſink in water, being burnt to aſhes will yield a much leſs weight of them (whereof I found but a ſmall part to be alkalizate) than much lighter vegetables: as alſo that the black charcoal of it will not ſink as did the wood, but ſwim; which argues, that the differing gravity of bodies proceeds chiefly from the particular texture, as is manifeſt in gold, the cloſeſt and compacteſt of bodies, which is many times heavier than we can poſſiby make any parcel of earth of the ſame bulk. I will not examine, what may be argued touching the gravity, or quality analogous thereunto, of even celeſtial bodies, from the motion of the ſpots about the ſun, and from the appearing equality of the ſuppoſed ſeas in the moon; nor conſider, how little thoſe phænomena would agree with what *Sennertus* preſumes concerning gravity. But further to invalidate his ſuppoſition, I ſhall demand, upon what chymical principle fluidity depends? And yet fluidity is, two or three perhaps excepted, the moſt diffuſed quality of the univerſe, and far more general than almoſt any other of thoſe, that are to be met with in any of the chymical principles, or Ariſtotelian elements; ſince not only the air, but that vaſt expanſion we call heaven, in compariſon of which, our terreſtrial globe (ſuppoſing it were all ſolid) is but a point, and perhaps too, the ſun and the fixt ſtars, are fluid bodies. I demand alſo, from which of the chymical principles, motion flows; which yet is an affection of matter much more general than any, that can be deduced from any of the three chymical principles. I might aſk the like queſtion concerning light, which is not only to be found in the kindled ſulphur of mixt bodies, but (not to mention thoſe ſorts of rotten woods, and rotten fiſh, that ſhine in the dark) in the tails of

living glow-worms, and in the vaſt bodies of the ſun and ſtars. I would gladly alſo know, in which of the three principles, the quality, we call ſound, reſides as in its proper ſubject; ſince either oil falling upon oil, or ſpirit upon ſpirit, or ſalt upon ſalt, in a great quantity, and from a conſiderable height, will make a noiſe, or, if you pleaſe, create a ſound, and (that the objection may reach the Ariſtotelians) ſo will alſo water upon water, and earth upon earth. And I could name other qualities to be met with in divers bodies, of which I ſuppoſe my adverſaries will not in haſte aſſign any ſubject, upon whoſe account it muſt needs be, that the quality belongs to all the other ſeveral bodies.

AND, before I proceed any further, I muſt here invite you to compare the ſuppoſition we are examining, with ſome other of the chymical tenets. For firſt they do in effect teach, that more than one quality may belong to, and be deduced from, one principle. For, they aſcribe to ſalt, taſtes, and the power of coagulation; to ſulphur, as well odours as inflammableneſs; and ſome of them aſcribe to mercury, colours; as all of them do effumability, as they ſpeak. And on the other ſide, it is evident, that volatility belongs in common to all the three principles, and to water too. For it is manifeſt, that chymical oils are volatile; that alſo divers ſalts, emerging upon the analyſis of many concretes, are very volatile, is plain from the fugitiveneſs of ſalt, of hartſhorn, fleſh, *&c.* aſcending in the diſtillation of thoſe bodies. How eaſily water may be made to aſcend in vapours, there is ſcarce any body, that has not obſerved. And as for what they call the mercurial principle of bodies, that is ſo apt to be raiſed in the form of ſteam, that *Paracelſus* and others define it by that aptneſs to fly up; ſo that (to draw that inference by the way) it ſeems not, that chymiſts have been accurate in their doctrine of qualities, and their reſpective principles, ſince they both derive ſeveral qualities from the ſame principle, and muſt aſcribe the ſame quality to almoſt all their principles and other bodies beſides. And thus much for the firſt thing taken for granted, without ſufficient proof, by your *Sennertus:* and to add that upon the by (continues *Carneades*) we may hence learn, what to judge of the way of argumentation, which that fierce champion of the Ariſtotelians againſt the chymiſts, *Anthoninus Guntherus Billichius* employs, where he pretends to prove againſt *Beguinus*, that not only the four elements do immediately concur to conſtitute every mixt body, and are both preſent in it, and obtainable from it, upon its diſſolution; but that in the *tria prima* themſelves, whereinto chymiſts are wont to reſolve mixt bodies, each of them clearly diſcovers itſelf to conſiſt of four elements. The ratiocination itſelf (purſues *Carneades*) being ſomewhat unuſual, I did the other day tranſcribe it, and (ſays he, pulling a paper out of his pocket) it is this: *Ordinamur, cum Beguino, à ligno viridi, quod ſi concremetur, videbis in ſudore aquam, in fumo aërem, in flamma & prunis ignem, terram in cineribus: quod ſi Beguino placuerit ex eo colligere humidum aquoſum, cohibere humidum oleaginoſum, extrahere ex cineribus ſalem; ego ipſi in unoquoque horum ſeorſim quatuor elementa ad oculum demonſtrabo, eodem artificio, quo in ligno viridi ea demonſtravi. Humorem aquoſum admovebo igni. Ipſe aquam ebullire videbit, in vapore aërem conſpiciet, ignem ſentiet in æſtu, plus minus terræ in ſedimento apparebit. Humor porro oleaginoſus aquam humiditate & fluiditate per ſe, accenſus vero ignem flamma prodit, fumo aërem, fuligine, nidore, & amurca terram. Salem denique ipſe Beguinus ſiccum vocat & terreſtrem, qui tamen nec fuſus aquam, nec cauſtica vi ignem celare poteſt; ignis vero violentia in halitus verſus nec ab aëre ſe alienum eſſe demonſtrat; idem de lacte, de ovis, de ſemine lini, de garyophillis, de nitro, de ſale marino, denique de antimonio, quod fuit de ligno viridi judicium; eadem de illorum partibus, quas Beguinus adducit, ſententia, quæ de viridis ligni humore aquoſo, quæ de liquore ejuſdem oleoſo, quæ de ſale fuit.*

In Theſſalo reſtiviva, cap. 10. pag. 73, 74.

THIS bold diſcourſe (reſumes *Carneades*, putting up again his paper) I think it were not very difficult to confute, if his arguments were as conſiderable, as our time will probably prove ſhort for the remaining and more neceſſary part of my diſcourſe: wherefore referring you for an anſwer to what was ſaid concerning the diſſipated parts of a burnt piece of green wood, to what I told *Themiſtius* on the like occaſion, I might eaſily ſhew you, how ſlightly and ſuperficially our *Guntherus* talks of the dividing the flame of green wood into his four elements; when he makes that vapour to be air, which being caught in glaſſes and condenſed, preſently diſcovers it ſelf to have been but an aggregate of innumerable very minute drops of liquor: and when he would prove the phlegm's being compoſed of fire, by that heat, which is adventitious to the liquors, and ceaſes upon the abſence of what produced it, (whether that be an agitation proceeding from the motion of the external fire, or the preſence of a multitude of igneous atoms pervading the pores of the veſſel, and nimbly permeating the whole body of the water) I might, I ſay, urge theſe and divers other weakneſſes of his diſcourſe. But I will rather take notice of what is more pertinent to the occaſion of this digreſſion; namely, that taking it for granted, that fluidity (with which he unwarily ſeems to confound humidity) muſt proceed from the element of water, he makes a chymical oil to conſiſt of that elementary liquor; and yet in the very next words proves, that it conſiſts alſo of fire, by its inflammability; not remembering, that exquiſitely pure ſpirit of wine is both more fluid than water itſelf, and yet will flame all away, without leaving the leaſt aqueous moiſture behind it, and without ſuch an amurca and ſoot as he would deduce the preſence of earth from. So that the ſame liquor may, according to his doctrine, be concluded by its great fluidity to be almoſt all water; and, by its burning all away, to be all diſguiſed fire. And by the like way of probation our author would ſhew, that the fixt ſalt of wood is compounded of the four elements. For (ſays he) being turned by the violence of the fire

into ſteams, it ſhews it ſelf to be of kin to air; whereas I doubt, whether he ever ſaw a true fixt ſalt (which to become ſo, muſt have already endured the violence of an incinerating fire) brought by the fire alone to aſcend in the form of exhalations; but I do not doubt, that if he did, and had caught thoſe exhalations in convenient veſſels, he would have found them as well as the ſteams of common ſalt, *&c.* of a ſaline, and not an aëreal nature. And whereas our author takes it alſo for granted,, that the fuſibility of ſalt muſt be deduced from water, it is indeed ſo much the effect of heat variouſly agitating the minute parts of a body, without regard to water, that gold (which by its being the heavieſt and fixedeſt of bodies, ſhould be the moſt earthy) will be brought to fuſion by a ſtrong fire, which ſure is more likely to drive away, than increaſe its aqueous ingredient, if it have any. And on the other ſide, for want of a ſufficient agitation of its minute parts, ice is not fluid, but ſolid; though he preſumes alſo, that the mordicant quality of bodies muſt proceed from a fiery ingredient: whereas, not to urge, that the light and inflammable parts, which are the moſt likely to belong to the element of fire, muſt probably be driven away by that time the violence of the fire has reduced the body to aſhes; not to urge this, I ſay, nor that oil of vitriol, which quenches fire, burns the tongue and fleſh of thoſe, that unwarily taſte or apply it, as a cauſtick doth, it is precarious to prove the preſence of fire in fixt ſalts from their cauſtick power, unleſs it were firſt ſhewn, that all the qualities aſcribed to ſalts muſt be deduced from thoſe of the elements; which, had I time, I could eaſily manifeſt to be no eaſy taſk. And not to mention, that our author makes a body, as homogeneous, as any he can produce for elementary, belong both to water and fire, though it be neither fluid nor inſipid, like water; nor light and volatile, like fire; he ſeems to omit in this anatomy the element of earth, ſave that he intimates, that the ſalt may paſs for that: but ſince a few lines before, he takes aſhes for earth, I ſee not how he will avoid an inconſiſtency either betwixt the parts of his diſcourſe, or betwixt ſome of them and his doctrine. For ſince there is a manifeſt difference betwixt the ſaline and the inſipid parts of aſhes, I ſee not how ſubſtances, that diſagree in ſuch notable qualities, can be both ſaid to be portions of an element, whoſe nature requires that it be homogeneous, eſpecially in this caſe where an analyſis by the fire is ſuppoſed to have ſeparated it from the admixture of other elements, which are confeſſed by moſt Ariſtotelians to be generally found in common earth, and to render it impure. And ſure, if when we have conſidered, for how little a diſparity's ſake the Peripateticks make theſe ſymbolizing bodies, air and fire, to be two diſtinct elements, we ſhall alſo conſider, that the ſaline part of aſhes is very ſtrongly taſted, and eaſily ſoluble in water; whereas the other part of the ſame aſhes is inſipid and indiſſoluble in the ſame liquor: not to add, that the one ſubſtance is opacous, and the other ſomewhat diaphanous, nor that they differ in divers other particulars; if we conſider thoſe things, I ſay, we ſhall hardly think, that both theſe ſubſtances are elementary earth. And as to what is ſometimes objected, that their ſaline taſte is only an effect of incineration and aduſtion, it has been elſewhere fully replied to, when propoſed by *Themiſtius*, and where it has been proved againſt him, that however inſipid earth may perhaps, by additaments, be turned into ſalt, yet it is not like it ſhould be ſo by the fire alone; for we ſee, that when we refine gold and ſilver, the violenteſt fires we can employ on them give them not the leaſt reliſh of ſaltneſs. And I think *Philoponus* has rightly obſerved, that the aſhes of ſome concretes contain very little ſalt, if any at all; for refiners ſuppoſe, that bone-aſhes are free from it, and therefore make uſe of them for teſts and cupels; which ought to be deſtitute of ſalt, leſt the violence of the fire ſhould bring them to vitrification. And having purpoſely and heedfully taſted a cupel made of only bone-aſhes and fair water, which I had cauſed to be expoſed to a very violent fire, acuated by the blaſt of a large pair of double bellows, I could not perceive, that the force of the fire had imparted to it the leaſt ſaltneſs, or ſo much as made it leſs inſipid.

BUT (ſays *Carneades*) ſince neither you nor I love repetitions, I ſhall not now make any of what elſe was urged againſt *Themiſtius*, but rather invite you to take notice with me, that when our author, though a learned man, and one that pretends ſkill enough in chymiſtry to reform the whole art, comes to make good his confident undertaking, to give us an ocular demonſtration of the immediate preſence of the four elements in the reſolution of green wood, he is fain to ſay things, that agree very little with one another. For about the beginning of that paſſage of his, lately recited to you, he makes the ſweat, as he call it, of the green wood, to be water; the ſmoke, air; the ſhining matter, fire; and the aſhes, earth: whereas a few lines after, he will, in each of theſe, nay (as I juſt now noted) in one diſtinct part of the aſhes, ſhew the four elements. So that either the former analyſis muſt be incompetent to prove that number of elements, ſince by it, the burnt concrete is not reduced into elementary bodies, but into ſuch as are yet each of them compounded of the four elements; or elſe theſe qualities, from which he endeavours to deduce the preſence of all the elements in the fixt ſalt, and each of the other ſeparated ſubſtances, will be but a precarious way of probation; eſpecially if you conſider, that the extracted alkali of wood, being, for aught appears, at leaſt as ſimilar a body, as any that the Peripateticks can ſhew us, if its differing qualities muſt argue the preſence of diſtinct elements, it will ſcarce be poſſible for them, by any way they know of employing the fire upon any body, to ſhew, that any body is a portion of a true element. And this recalls to my mind, that I am now but in an occaſional excurſion, which aiming only to ſhew, that the Peripateticks, as well as the chymiſts, take, in our preſent controverſy, ſomething for granted, which they ought

to

to prove, I ſhall return to my exceptions, where I ended the firſt of them, and further tell you, that neither is that the only precarious thing, that I take notice of in *Sennertus* his argumentation: for when he infers, that becauſe the qualities he mentions, as colours, ſmells, and the like, belong not to the elements, they therefore muſt to the chymical principles, he takes that for granted, which will not in haſte be proved; as I might here manifeſt, but that I may by and by have a fitter opportunity to take notice of it. And thus much at preſent may ſuffice to have diſcourſed againſt the ſuppoſition, that almoſt every quality muſt have ſome ἐκτικὸν πρῶτον, as they ſpeak, ſome native receptacle, wherein, as in its proper ſubject of inheſion, it peculiarly reſides; and on whoſe account that quality belongs to the other bodies, wherein, it is to be met with. Now this fundamental ſuppoſition being once deſtroyed, whatſoever is built upon it, muſt fall to ruin of it ſelf.

BUT I conſider further, that chymiſts are (for aught I have found) far from being able to explicate by any of the *tria prima*, thoſe qualities, which they pretend to belong primarily unto it, and in mixt bodies to deduce from it. It is true indeed, that ſuch qualities are not explicable by the four elements; but it will not therefore follow, that they are ſo by the three Hermetical principles: and this is it, that ſeems to have deceived the chymiſts, and is indeed a very common miſtake amongſt moſt diſputants, who argue, as if there could be but two opinions concerning the difficulty about which they contend; and conſequently they infer, that if their adverſaries opinion be erroneous, their's muſt needs be the truth; whereas many queſtions, and eſpecially in matters phyſiological, may admit of ſo many differing hypotheſes, that it will be very inconſiderate and fallacious to conclude (except where the opinions are preciſely contradictory) the truth of one from the falſity of another. And in our particular caſe it is no way neceſſary, that the properties of mixt bodies muſt be explicable either by the Hermetical, or the Ariſtotelian hypotheſis; there being divers other and more plauſible ways of explaining them, and eſpecially that, which deduces qualities from the motion, figure, and contrivance of the ſmall parts of bodies; as I think might be ſhewn, if the attempt were as ſeaſonable, as I fear it would be tedious.

I WILL allow then, that the chymiſts do not cauſeleſly accuſe the doctrine of the four elements of incompetency to explain the properties of compound bodies. And for this rejection of a vulgar error, they ought not to be denied what praiſe men may deſerve for exploding a doctrine, whoſe imperfections are ſo conſpicuous, that men needed but not to ſhut their eyes, to diſcover them. But I am miſtaken, if our hermetical philoſophers themſelves need not, as well as the Peripateticks, have recourſe to more fruitful and comprehenſive principles than the *tria prima*, to make out the properties of the bodies they converſe with. Not to accumulate examples to this purpoſe, becauſe I hope for a fitter opportunity to proſecute this ſubject, let us at preſent only point at colour, that you may gueſs by what they ſay of ſo obvious and familiar a quality, how little inſtruction we are to expect from the *tria prima* in thoſe more abſtruſe ones, which they, with the Ariſtotelians, ſtyle occult. For about colours, neither do they at all agree among themſelves, nor have I met with any one, of which of the three perſuaſions ſoever, that does intelligibly explicate them. The vulgar chymiſts are wont to aſcribe colours to mercury; *Paracelſus* in divers places attributes them to ſalt; and *Sennertus*, having recited their differing opinions, diſſents from both; and refers colours rather unto ſulphur. But how colours do, nay, how they may, ariſe from either of theſe principles, I think you will ſcarce ſay, that any has yet intelligibly explicated. And if Mr. *Boyle* will allow me to ſhew you the experiments, which he has collected about colours, you will, I doubt not, confeſs, that bodies exhibit colours, not upon the account of the predominancy of this or that principle in them, but upon that of their texture, and eſpecially the diſpoſition of their ſuperficial parts; whereby the light rebounding thence to the eye is ſo modified, as by differing impreſſions variouſly to affect the organs of ſight. I might here take notice of the pleaſing variety of colours exhibited by the triangular glaſs (as it is wont to be called) and demand, what addition or decrement of either ſalt, ſulphur, or mercury, befalls the body of the glaſs by being priſmatically figured; and yet it is known, that without that ſhape it would not afford thoſe colours as it does. But becauſe it may be objected, that theſe are not real, but apparent colours; that I may not loſe time in examining the diſtinction, I will alledge againſt the chymiſts a couple of examples of real and permanent colours drawn from metalline bodies; and repreſent, that without the addition of any extraneous body, quickſilver may by the fire alone, and that in glaſs-veſſels, be deprived of its ſilver-like colour, and be turned into a red body; and from this red body without addition likewiſe may be obtained a mercury bright and ſpecular as it was before. So that I have here a laſting colour generated and deſtroyed (as I have ſeen) at pleaſure, without adding or taking away either mercury, ſalt, or ſulphur. And if you take a clean and ſlender piece of hardened ſteel, and apply to it the flame of a candle at ſome little diſtance ſhort of the point, you ſhall not have held the ſteel long in the flame, but you ſhall perceive divers colours, as yellow, red and blue, to appear upon the ſurface of the metal, and, as it were, run along in chaſe of one another towards the point; ſo that the ſame body, and that in one and the ſame part, may not only have a new colour produced in it, but exhibit ſucceſſively divers colours within a minute of an hour, or thereabouts; and any of theſe colours may, by removing the ſteel from the fire, become permanent, and laſt many years. And this production and variety of colours cannot reaſonably be ſuppoſed to

De Conſ. & Diſſen. cap. 11. p. 186.

proceed from the acceſſion of any of the three principles, to which of them ſoever chymiſts will be pleaſed to aſcribe colours; eſpecially conſidering, that if you but ſuddenly refrigerate that iron, firſt made red-hot, it will be hardened and colourleſs again; and not only by the flame of a candle, but by any other equivalent heat conveniently applied, the like colours will again be made to appear and ſucceed one another, as at the firſt. But I muſt not any further proſecute an occaſional diſcourſe, though that were not ſo difficult for me to do, as I fear it would be for the chymiſts to give a better account of the other qualities, by their principles, than they have done of colours. And your *Sennertus* himſelf (though an author I much value) would I fear have been exceedingly puzzled to reſolve, by the *tria prima*, half that catalogue of problems, which he challenges the vulgar Peripateticks to explicate by their four elements. And ſuppoſing it were true, that ſalt or ſulphur were the principle, to which this or that quality may be peculiarly referred, yet though he, that teaches us this, teaches us ſomething concerning that quality, yet he teaches us but ſomething. For indeed he does not teach us that, which can in any tolerablemea ſure ſatisfy an inquiſitive ſearcher after truth. For what is it to me to know, that ſuch a quality reſides in ſuch a principle or element, whilſt I remain altogether ignorant of the cauſe of that quality, and the manner of its production and operation? How little do I know more than any ordinary man of gravity, if I know but that the heavineſs of mixt bodies proceeds from that of the earth they are compoſed of, if I know not the reaſon, why the earth is heavy? and how little does the chymiſt teach the philoſopher of the nature of purgation, if he only tells him, that the purgative virtue of medicines reſides in their ſalt? For, beſides that this muſt not be conceded without limitation, ſince the purging parts of many vegetables extracted by the water, wherein they are infuſed, are at moſt but ſuch compounded ſalts, (I mean mingled with oil, and ſpirit, and earth, as tartar and divers other ſubjects of the vegetable kingdom afford;) and ſince too that quickſilver precipitated either with gold, or without addition, into a powder, is wont to be ſtrongly enough cathartical, though the chymiſts have not yet proved, that either gold or mercury have any ſalt at all, much leſs any that is purgative; beſides this, I ſay, how little is it to me, to know, that it is the ſalt of the rhubarb (for inſtance) that purges, if I find, that it does not purge as ſalt; ſince ſcarce any elementary ſalt is in ſmall quantity cathartical; and if I know not how purgation in general is effected in a human body? In a word, as it is one thing to know a man's lodging, and another, to be acquainted with him; ſo it may be one thing to know the ſubject, wherein a quality principally reſides, and another thing to have a right notion and knowledge of the quality itſelf. Now that, which I take to be the reaſon of this chymical deficiency, is the ſame, upon whoſe account I think the Ariſtotelian and divers other theories incompetent to explicate the origin of qualities.

Senn. *de Conſ & Diſſen* p. 165, 166.

For I am apt to think, that men will never be able to explain the phænomena of nature, while they endeavour to deduce them only from the preſence and proportion of ſuch or ſuch material ingredients, and conſider ſuch ingredients or elements as bodies in a ſtate of reſt; whereas indeed the greateſt part of the affections of matter, and conſequently of the phænomena of nature, ſeems to depend upon the motion and the contrivance of the ſmall parts of bodies. For it is by motion, that one part of matter acts upon another; and it is, for the moſt part, the texture of the body, upon which the moving parts ſtrike, that modifies the motion or impreſſion, and concurs with it to the production of thoſe effects, which make up the chief part of the naturaliſt's theme.

BUT (ſays *Eleutherius*) methinks for all this, you have left ſome part of what I alledged, in behalf of the three principles, unanſwered. For all that you have ſaid will not keep this from being a uſeful diſcovery, that ſince in the ſalt of one concrete, in the ſulphur of another, and the mercury of a third, the medicinal virtue of it reſides; that principle ought to be ſeparated from the reſt, and there the deſired faculty muſt be ſought for.

I NEVER denied (replies *Carneades*) that the notion of the *tria prima* may be of ſome uſe; but (continues he, laughing) by what you now alledge for it, it will but appear, that it is uſeful to apothecaries, rather than to philoſophers; the being able to make things operative being ſufficient to thoſe, whereas the knowledge of cauſes is the thing looked after by theſe. And let me tell you, *Eleutherius*, even this itſelf will need to be entertained with ſome caution.

FOR firſt, it will not preſently follow, that if the purgative or other virtue of a ſimple may be eaſily extracted by water or ſpirit of wine, it reſides in the ſalt or ſulphur of the concrete; ſince unleſs the body hath before been reſolved by the fire, or ſome other powerful agent, it will, for the moſt part, afford in the liquors I have named, rather the finer compounded parts of itſelf, than the elementary ones. As I noted before, that water will diſſolve not only pure ſalts, but cryſtals of tartar, gum arabick, myrrh and other compound bodies. As alſo ſpirit of wine will diſſolve not only the pure ſulphur of concretes, but likewiſe the whole ſubſtance of divers reſinous bodies, as benzoin, the gummous parts of jalap, gum lacca, and other bodies, that are counted perfectly mixt. And we ſee, that the extracts made either with water or ſpirit of wine are not of a ſimple and elementary nature, but maſſes conſiſting of the looſer corpuſcles, and finer parts of the concretes whence they are drawn; ſince by diſtillation they may be divided into more elementary ſubſtances.

NEXT, we may conſider, that even when there intervenes a chymical reſolution by the fire, it is ſeldom in the ſaline or ſulphureous principle, as ſuch, that the deſired faculty of the concrete reſides; but as that titular ſalt or ſulphur is yet a mixt body, though the ſaline or ſulphureous nature be predominant in

it. For, if in chymical reſolutions, the ſeparated ſubſtances were pure and ſimple bodies, and of a perfect elementary nature; no one would be indued with more ſpecifick virtues, than another; and their qualities would differ as little as do thoſe of water. And let me add this upon the by, that even eminent chymiſts have ſuffered themſelves to be reprehended by me for their over-great diligence in purifying ſome of the things they obtain by fire from mixt bodies. For though ſuch compleatly purified ingredients of bodies might perhaps be more ſatisfactory to our underſtanding, yet others are often more uſeful to our lives; the efficacy of ſuch chymical productions depending moſt upon what they retain of the bodies, whence they are ſeparated, or gain by the new aſſociations of the diſſipated among themſelves; whereas, if they were meerly elementary, their uſes would be comparatively very ſmall; and the virtues of ſulphurs, ſalts, or other ſuch ſubſtances of one denomination, would be the very ſame.

AND by the way, *Eleutherius*, I am inclined upon this ground to think, that the artificial reſolution of compound bodies by fire does not ſo much enrich mankind, as it divides them into their ſuppoſed principles; as upon the ſcore of its making new compounds by new combinations of the diſſipated parts of the reſolved body. For by this means the number of mixt bodies is conſiderably increaſed; and many of thoſe new productions are endowed with uſeful qualities; divers of which they owe not to the body, from which they were obtained, but to their newly-acquired texture.

BUT thirdly, that, which is principally to be noted, is this, that as there are divers concretes, whoſe faculties reſide in ſome one or other of thoſe differing ſubſtances, that chymiſts call their ſulphurs, ſalts, and mercuries; and conſequently may be beſt obtained, by analyzing the concrete, whereby the deſired principles may be had ſever'd or freed from the reſt; ſo there are others, wherein the nobleſt properties lodge not in the ſalt, or ſulphur, or mercury, but depend immediately upon the form, or (if you will) reſult from the determinate ſtructure of the whole concrete; and conſequently they, that go about to extract the virtues of ſuch bodies, by expoſing them to the violence of the fire, do exceedingly miſtake, and take the way to deſtroy what they would obtain.

I REMEMBER that *Helmont* himſelf ſomewhere confeſſes, that as the fire betters ſome things, and improves their virtues, ſo it ſpoils others, and makes them degenerate. And elſewhere he judiciouſly affirms, that there may be ſometimes greater virtue in a ſimple, ſuch as nature has made it, than in any thing, that can by the fire be ſeparated from it. And leſt you ſhould doubt, whether he means by the virtues of things thoſe, that are medical; he has in one place this ingenuous confeſſion; *Valde abſurdum eſt* (ſays he) *ex omnibus rebus extracta facere, ſalia, quintas eſſentias; præſertim ex ſubſtantiis per ſe planè vel ſubtilibus vel homogeneis, quales ſunt uniones, corallia, moſcus, ambra, &c.* Conſonantly whereunto he alſo tells us, (and vouches the famous *Platerus*, for having candidly given the ſame advertiſement to his auditors,) that ſome things have greater virtues, and better ſuited to our human nature, when unprepared, than when they have paſt the chymiſts fire: as we ſee, ſays my author, in pepper; of which ſome grains ſwallowed perform more towards the relief of a diſtempered ſtomach, than a great quantity of the oil of the ſame ſpice. *Vide* Jer. ad Beguin. Lib. 1. Cap. 17.

IT has been (purſues *Carneades*) by our friend here preſent obſerved concerning ſalt-petre, that none of the ſubſtances, into which the fire is wont to divide it, retains either the taſte, the cooling virtue, or ſome other of the properties of the concrete; and that each of thoſe ſubſtances acquires new qualities not to be found in ſalt-petre it ſelf. The ſhining property of the tails of glow-worms does ſurvive but ſo ſhort a time the little animal made conſpicuous by it, that inquiſitive men have not ſcrupled publickly to deride *Baptiſta Porta* and others; who, deluded perhaps with ſome chymical ſurmiſes, have ventured to preſcribe the diſtillation of a water from the tails of glow-worms, as a ſure way to obtain a liquor ſhining in the dark. To which I ſhall now add no other example than that afforded us by amber; which, whilſt it remains an intire body, is endowed with an electrical faculty of drawing to it ſelf feathers, ſtraws, and ſuch like bodies; which I never could obſerve either in its ſalt, its ſpirit, its oil, or in the body I remember I once made by the re-union of its divided elements; none of theſe having ſuch a texture as the intire concrete. And however chymiſts boldly deduce ſuch and ſuch properties from this or that proportion of their component principles; yet in concretes, that abound with this or that ingredient, it is not always ſo much by virtue of its preſence, nor its plenty, that the concrete is qualified to perform ſuch and ſuch effects; as upon the account of the particular texture of that and the other ingredients, aſſociated after a determinate manner into one concrete: though poſſibly ſuch a proportion of that ingredient may be more convenient than another, for the conſtituting of ſuch a body. Thus in a clock, the hand is moved upon the dial, the bell is ſtruck, and the other actions belonging to the engine are performed, not becauſe the wheels are of braſs or iron, or part of one metal and part of another, or becauſe the weights are of lead; but by virtue of the ſize, ſhape, bigneſs, and coaptation of the ſeveral parts; which would perform the ſame things, though the wheels were of ſilver, or lead, or wood, and the weights of ſtone or clay, provided the fabrick or contrivance of the engine were the ſame: though it be not to be denied, that braſs and ſteel are more convenient materials to make clock-wheels of, than lead, or wood. And to let you ſee, *Eleutherius*, that it is ſometimes at leaſt,

Helmont. *Pharm. & Dijpen. Nov.* pag. 498. *Credo* (ſays he) *ſimplicia in ſua ſimplicitate eſſe ſufficientia pro ſanatione omnium morborum.* Nay, *Barthius*, even in a comment upon *Beguinus*, ſcruples not to make this acknowledgment;

leaſt, upon the texture of the ſmall parts of a body, and not always upon the preſence, or receſs, or increaſe, or decrement of any one of its principles, that it may loſe ſome ſuch qualities, and acquire ſome ſuch others, as are thought very ſtrongly inherent to the bodies they reſide in; I will add to what may, from my paſt diſcourſe, be referred to this purpoſe, this notable example, from my own experience; that lead may, without any additament, and only by various applications of the fire, loſe its colour; and acquire ſometimes a grey, ſometimes a yellowiſh, ſometimes a red, ſometimes an amethyſtine colour; and after having paſt through theſe, and perhaps divers others, again recover its leaden colour, and be made a bright body. That alſo this lead, which is ſo flexible a metal, may be made as brittle as glaſs, and preſently be brought to be again flexible and malleable as before. And beſides that the ſame lead, which I find by microſcopes to be one of the moſt opacous bodies in the world, may be reduced to a fine tranſparent glaſs; whence yet it may return to an opacous nature again; and all this, as I ſaid, without the addition of any extraneous body, and meerly by the manner and method of expoſing it to the fire.

BUT (ſays *Carneades*) after having already put you to ſo prolix a trouble, it is time for me to relieve you with a promiſe of putting ſpeedily a period to it; and to make good that promiſe, I ſhall, from all that I have hitherto diſcourſed with you, deduce but this one propoſition by way of corollary: *That it may as yet be doubted, whether or no there be any determinate number of elements*; *or, if you pleaſe, whether or no all compound bodies do conſiſt of the ſame number of elementary ingredients or material principles.*

THIS being but an inference from the foregoing diſcourſe, it will not be requiſite to inſiſt at large on the proofs of it; but only to point at the chief of them, and refer you for particulars to what has been already delivered.

IN the firſt place then, from what has been ſo largely diſcourſed, it may appear, that the experiments wont to be brought, whether by the common Peripateticks, or by the vulgar chymiſts, to demonſtrate, that all mixt bodies are made up preciſely either of the four elements, or the three hypoſtatical principles, do not evince what they are alledged to prove. And as for the other common arguments, pretended to be drawn from reaſon in favour of the Ariſtotelian hypotheſis, (for the chymiſts are wont to rely almoſt altogether upon experiments;) they are commonly grounded upon ſuch unreaſonable or precarious ſuppoſitions, that it is altogether as eaſy and as juſt for any man to reject them, as for thoſe, that take them for granted, to aſſert them, being indeed all of them as indemonſtrable as the concluſion to be inferred from them; and ſome of them ſo manifeſtly weak and prooffleſs, that he muſt be a very courteous adverſary, that can be willing to grant them; and as unſkilful a one, that can be compelled to do ſo.

IN the next place, it may be conſidered, if what thoſe patriarchs of the Spagyriſts, *Paracelſus* and *Helmont*, do on divers occaſions poſitively deliver, be true; namely, that the alkaheſt does reſolve all mixt bodies into other principles than the fire, it muſt be decided, which of the two reſolutions (that made by the alkaheſt, or that made by the fire) ſhall determine the number of the elements, before we can be certain how many there are.

AND in the mean time, we may take notice in the laſt place, that as the diſtinct ſubſtances, whereinto the alkaheſt divides bodies, are affirmed to be differing in nature from thoſe, whereunto they are wont to be reduced by fire, and * to be obtained from ſome bodies more in number than from ſome others; ſince he tells us, he could totally reduce all ſorts of ſtones into ſalt only, whereas of a coal he had two diſtinct liquors: ſo, although we ſhould acquieſce in that reſolution which is made by fire, we find not, that all mixt bodies are thereby divided into the ſame number of elements and principles; ſome concretes affording more of them than others do; nay, and ſometimes this or that body affording a greater number of differing ſubſtances by one way of management, than the ſame yields by another. And they, that out of gold, or mercury, or *Muſcovy*-glaſs, will draw me as many diſtinct ſubſtances, as I can ſeparate from vitriol, or from the juice of grapes variouſly ordered, may teach me that, which I ſhall very thankfully learn. Nor does it appear more congruous to that variety, that ſo much conduceth to the perfection of the univerſe, that all elemented bodies be compounded of the ſame number of elements, than it would be for a language, that all its words ſhould conſiſt of the ſame number of letters.

* *Novi ſaxum & lapides omnes in merum ſalem ſuo ſaxo aut lapidi & æquiponderantem reducere abſque omni prorſus ſulphure aut mercurio.* Helmont. pag. 490.

THE SCEPTICAL CHYMIST:

OR,

A Paradoxical Appendix to the foregoing Treatiſe.

PART VI.

HERE *Carneades* having diſpatched what he thought requiſite to oppoſe againſt what the chymiſts are wont to alledge for proof of their three principles, pauſed a while, and looked about him to diſcover, whether it were time for him and his friend to rejoin the reſt of the company. But *Eleutherius* perceiving nothing yet to forbid them to proſecute their diſcourſe a little further, ſaid to his friend, (who had likewiſe taken notice of the ſame thing) I half expected, *Carneades*, that after you had ſo freely declared your doubting, whether there be any determinate number of elements, you would have proceeded to queſtion, whether there be any elements at all. And I confeſs it will be a trouble to me, if you defeat me of my expectation; eſpecially ſince you ſee the leiſure we have allowed us may probably ſuffice to examine that paradox; becauſe you have ſo largely deduced already many things pertinent to it, that you need but intimate how you would have them applied, and what you would infer from them.

CARNEADES having in vain repreſented, that their leiſure could be but very ſhort, that he had already prated very long, that he was unprepared to maintain ſo great and ſo invidious a paradox, was at length prevailed with to tell his friend; Since, *Eleutherius*, you will have me diſcourſe *extempore* of the paradox you mention, I am content, (though more perhaps to expreſs my obedience, than my opinion) to tell you, that (ſuppoſing the truth of *Helmont*'s and *Paracelſus*'s alkaheſtical experiments, if I may ſo call them) though it may ſeem extravagant, yet it is not abſurd to doubt, whether, for aught has been proved, there be a neceſſity to admit any elements, or hypoſtatical principles, at all.

AND, as formerly, ſo now, to avoid the needleſs trouble of diſputing ſeverally with the Ariſtotelians and the chymiſts, I will addreſs my ſelf to oppoſe them I have laſt named, becauſe their doctrine about the elements is more applauded by the moderns, as pretending highly to be grounded upon experience. And, to deal not only fairly, but favourably with them, I will allow them to take in earth and water to their other principles. Which I conſent to the rather, that my diſcourſe may the better reach the tenets of the Peripateticks; who cannot plead for any ſo probably, as for thoſe two elements; that of fire above the air being generally by judicious men exploded as an imaginary thing; and the air not concurring to compoſe mixt bodies as one of their elements, but only lodging in their pores, or rather repleniſhing, by reaſon of its weight and fluidity, all thoſe cavities of bodies here below, whether compounded or not, that are big enough to admit it, and are not filled up with any groſſer ſubſtance.

AND, to prevent miſtakes, I muſt advertiſe you, that I now mean by elements, as thoſe chymiſts, that ſpeak plaineſt, do by their principles, certain primitive and ſimple, or perfectly unmingled bodies; which not being made of any other bodies, or of one another, are the ingredients, of which all thoſe called perfectly mixt bodies are immediately compounded, and into which they are ultimately reſolved: now whether there be any one ſuch body to be conſtantly met with in all, and each, of thoſe, that are ſaid to be elemented bodies, is the thing I now queſtion.

BY this ſtate of the controverſy you will, I ſuppoſe, gueſs, that I need not be ſo abſurd, as to deny, that there are ſuch bodies as earth and water, and quickſilver and ſulphur: but I look upon earth and water, as component parts of the univerſe, or rather of the terreſtrial globe, not of all mixt bodies. And though I will not peremptorily deny, that there may ſometimes either a running mercury, or a combuſtible ſubſtance be obtained from a mineral, or even a metal; yet I need not concede either of them to be an element in the ſenſe above declared; as I ſhall have occaſion to ſhew you by and by.

To give you then a brief account of the grounds I intend to proceed upon, I muſt tell you, that in matters of philoſophy, this ſeems to me a ſufficient reaſon to doubt of a known and important propoſition, that the truth of it is not yet by any competent proof made to appear. And congruouſly hereunto, if I ſhew, that the grounds, upon which men are perſuaded, that there are elements, are unable to ſatisfy a conſidering man, I ſuppoſe my doubts will appear rational.

Now the conſiderations, that induce men to think, that there are elements, may be conveniently enough referred to two heads: namely, the one, that it is neceſſary, that nature make uſe of elements to conſtitute the bodies that are reputed mixt. And the other, that the reſolution of ſuch bodies manifeſts, that nature had compounded them of elementary ones.

IN reference to the former of theſe conſiderations, there are two or three things, that I have to repreſent. And I will begin with reminding you of the experiments I not long ſince related to you concerning the growth of pompions, mint, and other vegetables out of fair water. For by thoſe experiments it ſeems evident, that water may be tranſmuted into all the

other

other elements; from whence it may be inferred, both, that it is not every thing chymiſts will call ſalt, ſulphur, or ſpirit, that needs always be a primordiate and ingenerable body; and that nature may contex a plant (though that be a perfectly mixt concrete) without having all the elements previouſly preſented to her to compound it of. And, if you will allow the relation I mentioned out of Monſieur *de Rochas* to be true; then may not only plants, but animals and minerals too, be produced out of water. And however there is little doubt to be made, but that the plants my trials afforded me, as they were like in ſo many other reſpects to the reſt of the plants of the ſame denomination; ſo they would, in caſe I had reduced them to putrefaction, have likewiſe produced worms or other inſects, as well as the reſembling vegetables are wont to do: ſo that water may, by various ſeminal principles, be ſucceſſively tranſmuted into both plants and animals. And if we conſider, that not only men, but even ſucking children are, but too often, tormented with ſolid ſtones; and that divers ſorts of beaſts themſelves, (whatever *Helmont* againſt experience thinks to the contrary) may be troubled with great and heavy ſtones in their kidneys and bladders, though they feed but upon graſs and other vegetables, that are perhaps but diſguiſed water; it will not ſeem improbable, that even ſome concretes of a mineral nature may likewiſe be formed of water.

WE may further take notice, that as a plant may be nouriſhed, and conſequently may conſiſt of common water; ſo may both plants and animals, (perhaps even from their ſeminal rudiments) conſiſt of compound bodies, without having any thing merely elementary brought them by nature to be compounded by them: this is evident in divers men, who whilſt they were infants were fed only with milk, afterwards live altogether upon fleſh, fiſh, wine, and other perfectly mixt bodies. It may be ſeen alſo in ſheep, who, on ſome of our Engliſh downs or plains, grow very fat by feeding upon the graſs, without ſcarce drinking at all; and yet more manifeſtly in the maggots, that breed and grow up to their full bigneſs within the pulps of apples, pears, or the like fruit. We ſee alſo, that dungs, that abound with a mixt ſalt, give a much more ſpeedy increment to corn and other vegetables, than water alone would do: and it hath been aſſured me by a man experienced in ſuch matters, that ſometimes, when, to bring up roots very early, the mould they were planted in was made overrich, the very ſubſtance of the plant has taſted of the dung. And let us alſo conſider a graft of one kind of fruit upon the upper bough of a tree of another kind; as (for inſtance) the ſcion of a pear upon a white-thorn; for there the aſcending liquor is already altered, either by the root, or in its aſcent by the bark, or both ways, and becomes a new mixt body: as may appear by the differing qualities to be met with in the ſaps of ſeveral trees; as particularly, the medicinal virtue of birch-water, which I have ſometimes drunk upon *Helmont*'s great and not undeſerved commendation. Now the graft, being faſtened to the ſtock, muſt neceſſarily nouriſh itſelf, and produce its fruit, only out of this compound juice prepared for it by the ſtock, being unable to come at any other aliment. And if we conſider, how much of the vegetable he feeds upon may (as we noted above) remain in an animal; we may eaſily ſuppoſe, that the blood of that animal, who feeds upon this, though it be a well-conſtituted liquor, and have all the differing corpuſcles, that make it up, kept in order by one preſiding form, may be a ſtrangely decompounded body, many of its parts being themſelves decompounded. So little is it neceſſary, that even in the mixtures, which nature her ſelf makes in animal and vegetable bodies, ſhe ſhould have pure elements at hand to make her compoſitions of.

HAVING ſaid thus much touching the conſtitution of plants and animals, I might perhaps be able to ſay as much touching that of minerals, and even metals, if it were as eaſy for us to make experiment in order to the production of theſe, as of thoſe. But the growth or increment of minerals being uſually a work of exceſſively long time, and for the moſt part performed in the bowels of the earth, where we cannot ſee it, I muſt inſtead of experiments make uſe, on this occaſion, of obſervations.

THAT ſtones were not all made at once, but that ſome of them are now-a-days generated, may (though it be denied by ſome) be fully proved by ſeveral examples, of which I ſhall now ſcarce alledge any other, than that famous place in *France* known by the name of *Les Caves Goutieres*, where the water falling from the upper parts of the cave to the ground, does preſently there condenſe into little ſtones, of ſuch figures, as the drops, falling either ſeverally or upon one another, and coagulating preſently into ſtone, chance to exhibit. Of theſe ſtones ſome ingenious friends of ours, that went a while ſince to viſit that place, did me the favour to preſent me with ſome, that they brought thence. And I remember, that both that ſober relator of his voyages, *Van Linſchoten*, and another good author, inform us, that in the diamond mines (as they call them) in the *Eaſt-Indies*, when having digged the earth, though to no great depth, they find diamonds, and take them quite away; yet in a very few years they find in the ſame place new diamonds produced there ſince. From both which relations, eſpecially the firſt, it ſeems probable, that nature does not always ſtay for divers elementary bodies, when ſhe is to produce ſtones. And as for metals themſelves, authors of good note aſſure us, that even they were not in the beginning produced at once altogether, but have been obſerved to grow; ſo that what was not a mineral or metal before, became one afterwards. Of this it were eaſy to alledge many teſtimonies of profeſſed chymiſts. But that they may have the greater authority, I ſhall rather preſent you with a few borrowed from more unſuſpected writers: *Sulphuris mineram* (as the inquiſitive *P. Fallopius* notes) *quæ nutrix eſt caloris ſubterranei fabri ſeu archæi fontium & mineralium, infra terram citiſſimè renaſci teſtantur hiſtoriæ metallicæ.*

metallicæ. Sunt enim loca, è quibus ſi hoc anno ſulphur effoſſum fuerit, intermiſſa foſſione per quadriennium, redeunt foſſores, & omnia ſulphure, ut antea, rurſus inveniunt plena. Pliny relates, *in Italiæ inſula Ilva, gigni ferri metallum.* Strabo *multo expreſſius; effoſſum ibi metallum ſemper regenerari. Nam ſi effoſſio ſpatio centum annorum intermittebatur, & iterum illuc revertebantur, foſſores reperiſſe maximam copiam ferri regeneratam.* Which hiſtory not only is countenanced by *Fallopius*, from the income, which the iron of that iſland yielded the duke of *Florence* in his time; but is mentioned more expreſsly to our purpoſe by the learned *Ceſalpinus: Vena* (ſays he) *ferri copioſiſſima eſt in Italia; ob eam nobilitata Ilva Tyrrheni maris inſula incredibili copia etiam noſtris temporibus eam gignens: Nam terra, quæ eruitur, dum vena effoditur tota, procedente tempore in venam convertitur.* Which laſt clauſe is therefore very notable, becauſe from thence we may deduce, that earth, by a metalline plaſtick principle latent in it, may be in proceſs of time changed into a metal. And even * *Agricola* himſelf, though the chymiſts complain of him as their adverſary, acknowledges thus much and more; by telling us, that at a town called *Saga* in *Germany*, they dig up iron in the fields, by ſinking ditches two foot deep; and adding, that within the ſpace of ten years the ditches are digged again for iron ſince produced, as the ſame metal is wont to be obtained in *Ilva*. Alſo concerning lead, not to mention what even *Galen* notes, that it will increaſe both in bulk and weight, if it be long kept in vaults or cellars, where the air is groſs and thick, as he collects from the ſwelling of thoſe pieces of lead, that were imployed to faſten together the parts of old ſtatues. Not to mention this, I ſay, *Boccacius Certaldus*, as I find him quoted by a diligent writer, has this paſſage touching the growth of lead: *Feſſularum mons* (ſays he) *in Hetruria, Florentiæ civitati imminens, lapides plumbarios habet; qui ſi excidantur, brevi temporis ſpatio, novis incrementis inſtaurantur; ut* (annexes my author) *tradit Boccacius Certaldus, qui id compertiſſimum eſſe ſcribit. Nihil hoc novi eſt; ſed de eodem Plinius, lib. 34. Hiſt. Natur. cap. 17. dudum prodidit, inquiens, mirum in his ſolis plumbi metallis, quod derelicta fertilius reviviſcunt. In plumbariis ſecundo lapide ab Amberga dictis ad aſylum recrementa congeſta in cumulos, expoſita ſolibus pluviiſque paucis annis, reddunt ſuum metallum cum fœnore.* I might add to theſe (continues *Carneades*) many things, that I have met with concerning the generation of gold and ſilver. But for fear of wanting time, I ſhall mention but two or three narratives. The firſt you may find recorded by *Gerhardus* the phyſick profeſſor, in theſe words: *In valle* (ſays he) *Joachimica argentum graminis modo & more è lapidibus mineræ velut è radice excreviſſe digiti longitudine, teſtis eſt Dr. Schreterus, qui ejuſmodi venas aſpectu jucundas & admirabiles domi ſuæ aliis ſæpe monſtravit & donavit. Item aqua cærulea inventa eſt Annebergæ, ubi argentum erat adhuc in primo ente, quæ coagulata redacta eſt in calcem fixi & boni argenti.*

THE other two relations I have not met with in Latin authors, and yet they are both very memorable in themſelves, and pertinent to our preſent purpoſe.

THE firſt I meet with in the commentary of *Johannes Valebius* upon the *Kleine Baur*, in which that induſtrious chymiſt relates, with many circumſtances, that at a mine-town (if I may ſo Engliſh the German *Bergſtat*) eight miles or leagues diſtant from *Straſburg* called *Mariakirch*, a workman came to the overſeer, and deſired employment; but he telling him, that there was not any of the beſt ſort at preſent for him, added, that till he could be preferred to ſome ſuch, he might in the mean time, to avoid idleneſs, work in a grove or mine-pit thereabouts, which at that time was little eſteemed. This workman, after ſome weeks labour, had by a crack appearing in the ſtone upon a ſtroke given near the wall, an invitation given him to work his way through; which as ſoon as he had done, his eyes were ſaluted by a mighty ſtone or lump, which ſtood in the middle of the cleft (that had a hollow place behind it) upright, and in ſhew like an armed man; but conſiſted of pure fine ſilver having no vein or ore by it, or any other additament, but ſtood there free, having only under-foot ſomething like a burnt matter; and yet this one lump held in weight above 1000 marks, which, according to the Dutch account, makes 500 pound weight of fine ſilver. From which and other circumſtances my author gathers, that by the warmth of the place, the noble metalline ſpirits, (ſulphureous and mercurial) were carried from the neighbouring galleries or vaults, through other ſmaller cracks and clefts into that cavity, and there collected as in a cloſe chamber or cellar; whereinto when they were gotten, they did in proceſs of time ſettle into the fore-mentioned precious maſs of metal.

THE other German relation is of that great traveller and laborious chymiſt *Joannes* (not *Georgius*) *Agricola*; who, in his notes upon what *Poppius* has written of antimony, relates, that when he was among the Hungarian mines in the deep groves, he obſerved, that there would often ariſe in them a warm ſteam, (not of that malignant ſort, which the Germans call *Shwadt*, which, ſays he, is a mere poiſon, and often ſuffocates the diggers) which faſtened itſelf to the walls; and that coming again to review it after a couple of days, he diſcerned, that it was all very faſt, and gliſtering: whereupon, having collected it and diſtilled it *per retortam*, he obtained from it a fine ſpirit; adding, that the mine-men informed him, that this ſteam, or damp (as the Engliſhmen alſo call it, retaining the Dutch term) would at laſt have become a metal, as gold or ſilver.

I refer (ſays *Carneades*) to another occaſion, the uſe, that may be made of theſe narratives towards the explicating the nature of metals; and that of fixedneſs, malleableneſs, and ſome other

* *In Lygiis, ad Sagam oppidum, in pratis eruitur ferrum, foſſis ad altitudinem bipedaneam actis. Id decennio renatum, denuo foditur, non aliter ac Ilvæ ferrum.*

other qualities conſpicuous in them. And in the mean time, this I may at preſent deduce from theſe obſervations; that it is not very probable, that whenſoever a mineral, or even a metal, is to be generated in the bowels of the earth, nature needs to have at hand both ſalt and ſulphur, and mercury to compound it of: for, not to urge, that the two laſt relations ſeem leſs to favour the chymiſts than *Ariſtotle*, who would have metals generated of certain halitus or ſteams, the fore-mentioned obſervations together make it ſeem more likely, that the mineral earths, or thoſe metalline ſteams (wherewith probably ſuch earths are plentifully imbued) do contain in them ſome ſeminal rudiment, or ſomething equivalent thereunto; by whoſe plaſtick power the reſt of the matter, though perhaps terreſtrial and heavy, is, in tract of time, faſhioned into this or that metalline ore; almoſt (as I formerly noted) as that fair water was by the ſeminal principle of mint, pompions, and other vegetables, contrived into bodies anſwerable to ſuch ſeeds. And that ſuch alterations of terreſtrial matter are not impoſſible, ſeems evident from that notable practice of the boilers of ſalt-petre, who unanimouſly obſerve, as well here in *England* as in other countries, that if an earth pregnant with nitre be deprived, by the affuſion of water, of all its true and diſſoluble ſalt, yet the earth will, after ſome years, yield them ſalt-petre again: for which reaſon, ſome of the eminent and ſkilfulleſt of them keep it in heaps as a perpetual mine of ſalt-petre. Whence it may appear, that the ſeminal principle of nitre, latent in the earth, does, by degrees, transform the neighbouring matter into a nitrous body: for though I deny, that ſome volatile nitre may, by ſuch earths, be attracted (as they ſpeak) out of the air, yet that the innermoſt parts of ſuch great heaps, that lie ſo remote from the air, ſhould borrow from it all the nitre they abound with, is not probable, for other reaſons beſides the remoteneſs of the air, though I have not the leiſure to mention them.

AND I remember, that a perſon of great credit, and well acquainted with the ways of making vitriol, affirmed to me, that he had obſerved, that a kind of mineral, which abounds in that ſalt, being kept within doors, and not expoſed (as is uſual) to the free air and rains, did of it ſelf in no very long time turn into vitriol, not only in the outward or ſuperficial, but even in the internal and moſt central parts.

And I alſo remember, that I met with a certain kind of marchaſite, that lay together in great quantities under ground, which did, even in my chamber, in ſo few hours begin of it ſelf to turn into vitriol, that we need not diſtruſt the newly recited narrative. But to return to what I was ſaying of nitre; as nature made this ſalt-petre out of the once almoſt inodorous earth it was bred in, and did not find a very ſtinking and corroſive acid liquor, and a ſharp alcalizate ſalt to compound it of, though theſe be the bodies, into which the fire diſſolves it; ſo it were not neceſſary, that nature ſhould make up all metals and other minerals of pre-exiſtent ſalt, and ſulphur, and mercury, though ſuch bodies might by fire be obtained from it. Which one conſideration duly weighed is very conſiderable in the preſent controverſy: and to this agree well the relations of our two German chymiſts; for beſides that it cannot be convincingly proved, it is not ſo much as likely, that ſo languid and moderate a heat, as that within the mines, ſhould carry up to ſo great a height, though in the form of fumes, ſalt, ſulphur, and mercury; ſince we find in our diſtillations, that it requires a conſiderable degree of fire to raiſe, ſo much as to the height of one foot, not only ſalt, but even mercury it ſelf in cloſe veſſels. And if it be objected, that it ſeems by the ſtink, that is ſometimes obſerved, when lightning falls down here below, that ſulphureous ſteams may aſcend very high without any extraordinary degree of heat; it may be anſwered, among other things, that the ſulphur of ſilver is by chymiſts ſaid to be a fixt ſulphur, though not altogether ſo well digeſted as that of gold.

BUT, (proceeds *Carneades*) if it had not been to afford you ſome hints concerning the origin of metals, I need not have deduced any thing from theſe obſervations; it not being neceſſary to the validity of my argument, that my deductions from them ſhould be irrefragable, becauſe my adverſaries the Ariſtotelians and vulgar chymiſts do not, I preſume, know any better than I, *à priori*, of what ingredients Nature compounds metals and minerals. For their argument to prove, that thoſe bodies are made up of ſuch principles, is drawn *à poſteriori*; I mean from this, that upon the analyſis of mineral bodies they are reſolved into thoſe differing ſubſtances. That we may therefore examine this argument, let us proceed to conſider, what can be alledged in behalf of the elements from the reſolutions of bodies by the fire; which you remember was the ſecond topick, whence I told you the arguments of my adverſaries were deſumed.

AND that I may firſt diſpatch what I have to ſay concerning minerals, I will begin the remaining part of my diſcourſe with conſidering how the fire divides them.

AND firſt, I have partly noted above, that though chymiſts pretend from ſome to draw ſalt, from others running mercury, and from others a ſulphur; yet they have not hitherto taught us, by any way in uſe among them, to ſeparate any one principle, whether ſalt, ſulphur, or mercury, from all ſorts of minerals without exception. And thence I may be allowed to conclude, that there is not any of the elements, that is an ingredient of all bodies, ſince there are ſome, of which it is not ſo.

IN the next place, ſuppoſing, that either ſulphur or mercury were obtainable from all ſorts of minerals; yet ſtill this ſulphur or mercury would be but a compounded, not an elementary body, as I told you already on another occaſion. And certainly he, that takes notice of the wonderful operations of quickſilver, whether it be common, or drawn from mineral bodies, can ſcarce be ſo inconſiderate

as to think it of the very ſame nature with that immature and fugitive ſubſtance, which in vegetables and animals chymiſts have been pleaſed to call their mercury. So that when mercury is got by the help of the fire out of a metal or other mineral body, if we will not ſuppoſe, that it was not pre-exiſtent in it, but produced by the action of the fire upon the concrete, we may at leaſt ſuppoſe this quick-ſilver to have been a perfect body of its own kind (though perhaps leſs heterogeneous than more ſecondary mixts) which happened to be mingled *per minima*, and coagulated with the other ſubſtances, whereof the metal or mineral conſiſted. As may be exemplified, partly by native vermilion, wherein the quickſilver and ſulphur being exquiſitely blended both with one another, and that other coarſe mineral ſtuff (whatever it be) that harbours them, make up a red body differing enough from both; and yet from which part of quickſilver, and of the ſulphur, may be eaſily enough obtained; partly by thoſe mines, wherein nature has ſo curiouſly incorporated ſilver with lead, that it is extremely difficult, and yet poſſible to ſeparate the former out of the latter; and partly too by native vitriol, wherein the metalline corpuſcles are by ſkill and induſtry ſeparable from the ſaline ones, though they be ſo con-coagulated with them, that the whole concrete is reckoned among ſalts.

AND here I further obſerve, that I never could ſee any earth or water, properly ſo called, ſeparated from either gold or ſilver, (to name now no other metalline bodies;) and therefore to retort the argument upon my adverſaries, I may conclude, that ſince there are ſome bodies, in which, for aught appears, there is neither earth nor water; I may be allowed to conclude, that neither of thoſe two is an univerſal ingredient of all thoſe bodies, that are counted perfectly mixt, which I deſire you would remember againſt anon.

IT may indeed be objected, that the reaſon, why from gold or ſilver we cannot ſeparate any moiſture, is, becauſe that when it is melted out of the ore, the vehement fire requiſite to its fuſion forced away all the aqueous and fugitive moiſture; and the like fire may do from the materials of glaſs. To which I ſhall anſwer, that I remember I read not long ſince in the learned *Joſephus Acoſta**, who relates it upon his own obſervation, that in *America* (where he long lived) there is a kind of ſilver, which the Indians call *papas*, and ſometimes (ſays he) they find pieces very fine and pure like to ſmall round roots, the which is rare in that metal, but uſual in gold; concerning which metal he tells us, that beſides this they find ſome, which they call gold in grains, which he tells us are ſmall morſels of gold, that they find whole without mixture of any other metal, which hath no need of melting or refining in the fire.

I REMEMBER, that a very ſkilful and credible perſon affirmed to me, that being in the Hungarian mines he had the good fortune to ſee a mineral, that was there digged up, wherein pieces of gold of the length, and alſo almoſt of the bigneſs of a human finger, grew in the ore, as if they had been parts and branches of trees.

AND I have my ſelf ſeen a lump of whitiſh mineral, that was brought as a rarity to a great and knowing prince, wherein there grew here and there in the ſtone, which looked like a kind of ſpar, divers little lumps of fine gold, (for ſuch I was aſſured that trial had manifeſted it to be) ſome of them ſeeming to be about the bigneſs of peas.

BUT that is nothing to what our *Acoſta* † ſubjoins, which is indeed very memorable; namely, that of the morſels of native and pure gold, which we lately heard him mentioning, he had now and then ſeen ſome weighed many pounds: to which I ſhall add, that I my ſelf have ſeen a lump of ore not long ſince digged up, in whoſe ſtony part there grew, almoſt like trees, divers parcels, though not of gold, yet of (what perhaps mineraliſts will more wonder at) another metal, which ſeemed to be very pure or unmixt with any heterogeneous ſubſtances, and were ſome of them as big as my finger, if not bigger. But upon obſervations of this kind, though perhaps I could, yet I muſt not at preſent, dwell any longer.

TO proceed therefore now (ſays *Carneades*) to the conſideration of the analyſis of vegetables, although my trials give me no cauſe to doubt, but that out of moſt of them five differing ſubſtances may be obtained by the fire, yet I think it will not be ſo eaſily demonſtrated, that theſe deſerve to be called elements in the notion above explained.

AND before I deſcend to particulars, I ſhall repeat and premiſe this general conſideration, that theſe differing ſubſtances, that are called elements or principles, differ not from each other as metals, plants, and animals, or as ſuch creatures as are immediately produced each by its peculiar ſeed, and conſtitutes a diſtinct propagable ſort of creatures in the univerſe; but theſe are only various ſchemes of matter or ſubſtances, that differ from each other, but in conſiſtence (as running mercury and the ſame metal congealed by the vapour of lead) and ſome very few other accidents, as taſte, or ſmell, or inflammability, or the want of them. So that by a change of texture, not impoſſible to be wrought by the fire and other agents, that have the faculty, not only to diſſociate the ſmall parts of bodies, but afterwards to connect them after a new manner, the ſame parcel of matter may acquire or loſe ſuch accidents, as may ſuffice to denominate it ſalt, or ſulphur, or earth. If I were fully to clear to you my apprehenſions concerning this matter, I ſhould perhaps be obliged to acquaint you with divers of the conjectures (for I muſt yet call them no more) I have had concerning the principles of things purely corporeal: for though, becauſe I ſeem not ſatisfied with the vulgar doctrines, either of the Peripatetick or Paracelſian ſchools, many of thoſe, that know me, (and perhaps, among

* *Acoſta*'s Natural and Moral Hiſtory of the *Indies*, *L.* 3. *c.* 5. *p.* 212.
† See *Acoſta* in the fore-cited place, and the paſſage of *Pliny* quoted by him.

among them, *Eleutherius* himſelf) have thought me wedded to the Epicurean hypotheſis, (as others have miſtaken me for an Helmontian) yet if you knew how little converſant I have been with Epicurean authors, and how great a part of *Lucretius* himſelf I never yet had the curioſity to read, you would perchance be of another mind; eſpecially if I were to entertain you at large, I ſay not with my preſent notions, but with my former thoughts concerning the principles of things. But, as I ſaid above, fully to clear my apprehenſions would require a longer diſcourſe than we can now have.

FOR I ſhould tell you, that I have ſometimes thought it not unfit, that to the principles, which may be aſſigned to things, as the world is now conſtituted, we ſhould, if we conſider the great maſs of matter, as it was whilſt the univerſe was in making, add another, which may conveniently enough be called an architectonick principle or power; by which I mean thoſe various determinations, and that ſkilful guidance of the motions of the ſmall parts of the univerſal matter by the moſt wiſe author of things, which were neceſſary at the beginning to turn that confuſed chaos into this orderly and beautiful world; and eſpecially to contrive the bodies of animals and plants, and the ſeeds of thoſe things, whoſe kinds were to be propagated. For I confeſs I cannot well conceive, how from matter, barely put into motion, and then left to itſelf, there could emerge ſuch curious fabricks, as the bodies of men and perfect animals, and ſuch yet more admirably contrived parcels of matter, as the ſeeds of living creatures.

I SHOULD likewiſe tell you upon what grounds, and in what ſenſe, I ſuſpected the principles of the world, as it now is, to be three, matter, motion and reſt: I ſay, as the world now is, becauſe the preſent fabrick of the univerſe, and eſpecially the ſeeds of things, together with the eſtabliſhed courſe of nature, is a requiſite or condition, upon whoſe account divers things may be made out by our three principles, which otherwiſe would be very hard, if poſſible, to explicate.

I SHOULD moreover declare in general (for I pretend not to be able to do it otherwiſe) not only why I conceive that colours, odours, taſtes, fluidneſs and ſolidity, and thoſe other qualities, that diverſify and denominate bodies, may intelligibly be deduced from theſe three; but how two of the three Epicurean principles (which, I need not tell you, are magnitude, figure, and weight) are themſelves deducible from matter and motion; ſince the latter of theſe variouſly agitating, and, as it were, diſtracting the former, muſt needs disjoin its parts; which being actually ſeparated, muſt each of them neceſſarily both be of ſome ſize, and obtain ſome ſhape or other. Nor did I add to our principles the Ariſtotelian privation, partly for other reaſons, which I muſt not now ſtay to inſiſt on; and partly, becauſe it ſeems to be rather an antecedent, or a *terminus à quo*, than a true principle, as the ſtarting-poſt is none of the horſe's legs or limbs.

I SHOULD alſo explain, why and how I made reſt to be, though not ſo conſiderable a principle of things, as motion, yet a principle of them; partly, becauſe it is (for aught we know) as ancient at leaſt as it, and depends not upon motion, nor any other quality of matter; and partly, becauſe it may enable the body, in which it happens to be, both to continue in a ſtate of reſt, till ſome external force put it out of that ſtate, and to concur to the productions of divers changes in the bodies, that hit againſt it, by either quite ſtopping or leſſening their motion, (whilſt the body formerly at reſt receives all or part of it into itſelf) or elſe by giving a new byaſs, or ſome other modification, to motion, that is, to the grand and primary inſtrument, whereby nature produces all the changes and other qualities, that are to be met with in the world.

I SHOULD likewiſe, after all this, explain to you how, although matter, motion, and reſt, ſeemed to me to be the catholick principles of the univerſe, I thought the principles of particular bodies might be commodiouſly enough reduced to two; namely matter, and (what comprehends the two other, and their effects) the reſult, or aggregate, or complex of thoſe accidents, which are the motion or reſt, (for in ſome bodies both are not to be found) the bigneſs, figure, texture, and the thence reſulting qualities of the ſmall parts, which are neceſſary to intitle the body, whereto they belong, to this or that peculiar denomination; and diſcriminating it from others, to appropriate it to a determinate kind of things, (as yellowneſs, fixedneſs, ſuch a degree of weight, and of ductility, do make the portion of matter wherein they concur, to be reckoned among perfect metals, and obtain the name of gold;) this aggregate or reſult of accidents you may, if you pleaſe, call either ſtructure, or texture, (though indeed that do not ſo properly comprehend the motion of the conſtituent parts, eſpecially in caſe ſome of them be fluid) or what other appellation ſhall appear moſt expreſſive. Or if, retaining the vulgar term, you will call it the form of the thing it denominates, I ſhall not much oppoſe it; provided the word be interpreted to mean but what I have expreſſed, and not a ſcholaſtick ſubſtantial form, which ſo many intelligent men profeſs to be to them altogether unintelligible.

BUT (ſays *Carneades*) if you remember, that it is a ſceptick ſpeaks to you, and that it is not ſo much my preſent talk to make aſſertions as to ſuggeſt doubts, I hope you will look upon what I have propoſed, rather as a narrative of my former conjectures touching the principles of things, than as a reſolute declaration of my preſent opinions of them; eſpecially ſince although they cannot but appear very much to their diſadvantage, if you conſider them as they are propoſed, without thoſe reaſons and explanations, by which I could perhaps make them appear much leſs extravagant; yet I want time to offer you what may be alledged to clear and countenance theſe notions; my deſign in mentioning them unto you at preſent being, partly, to bring ſome light and confirmation to divers paſſages of my diſcourſe to

you; partly, to ſhew you, that I do not (as you ſeem to have ſuſpected) embrace all *Epicurus*'s principles, but diſſent from him in ſome main things, as well as from *Ariſtotle* and the chymiſts, in others; and partly alſo, or rather chiefly, to intimate to you the grounds, upon which I likewiſe differ from *Helmont* in this, that whereas he aſcribes almoſt all things, and even diſeaſes themſelves, to their determinate ſeeds, I am of opinion, that beſides the peculiar fabricks of the bodies of plants and animals (and perhaps alſo of ſome metals and minerals) which I take to be effects of ſeminal principles, there are many other bodies in nature, which have and deſerve diſtinct and proper names, but yet do but reſult from ſuch contextures of the matter they are made of, as may without determinate ſeeds be effected by heat, cold, artificial mixtures and compoſitions, and divers other cauſes, which ſometimes nature imploys of her own accord, and oftentimes man by his power and ſkill makes uſe of, to faſhion the matter according to his intentions. This may be exemplified both in the productions of nature, and in thoſe of art: of the firſt ſort I might name multitudes; but to ſhew how ſlight a variation of textures, without addition of new ingredients, may procure a parcel of matter divers names, and make it be lookt upon as different things;

I SHALL invite you to obſerve with me, that clouds, rain, hail, ſnow, froſt, and ice, may be but water, having its parts varied as to their ſize and diſtance in reſpect of each other, and as to motion and reſt. And among artificial productions we may take notice (to ſkip the cryſtals of tartar) of glaſs, regulus martis ſtellatus, and particularly of the ſugar of lead; which, though made of that inſipid metal and ſour ſalt of vinegar, has in it a ſweetneſs ſurpaſſing that of common ſugar, and divers other qualities, which being not to be found in either of its two ingredients, muſt be confeſſed to belong to the concrete itſelf, upon the account of its texture.

THIS conſideration premiſed, it will be, I hope, the more eaſy to perſuade you, that the fire may as well produce ſome new textures in a parcel of matter, as deſtroy the old.

WHEREFORE hoping, that you have not forgot the arguments formerly imployed againſt the doctrine of the *tria prima*; namely, that the ſalt, ſulphur, and mercury, into which the fire ſeems to reſolve vegetable and animal bodies, are yet compounded, not ſimple and elementary ſubſtances; and that (as appeared by the experiment of pompions) the *tria prima* may be made out of water; hoping, I ſay, that you remember theſe, and the other things, that I formerly repreſented to the ſame purpoſe, I ſhall now add only, that if we doubt not the truth of ſome of *Helmont's* relations, we may well doubt, whether any of theſe heterogeneities be (I ſay, not pre-exiſtent, ſo as to convene together, when a plant or animal is to be conſtituted, but) ſo much as in-exiſtent in the concrete, whence they are obtained, when the chymiſt firſt goes about to reſolve it. For, not to inſiſt upon the un-inflammable ſpirit of ſuch concretes, becauſe that may be pretended to be but a mixture of phlegm and ſalt, the oil or ſulphur of vegetables or animals is, according to him, reducible by the help of lixiviate ſalts into ſoap; as that ſoap is by the help of repeated diſtillations from a *caput mortuum* of chalk into inſipid water. And as for the ſaline ſubſtance, that ſeems ſeparable from mixt bodies, the ſame* *Helmont*'s trials give us cauſe to think, that it may be a production of the fire, which, by tranſporting and otherwiſe altering the particles of the matter, does bring it to a ſaline nature.

FOR I know (ſays he, in the place formerly alledged to another purpoſe) a way to reduce all ſtones into a mere ſalt of equal weight with the ſtone, whence it was produced, and that without any of the leaſt either ſulphur or mercury; which aſſeveration of my author would perhaps ſeem leſs incredible to you, if I durſt acquaint you with all I could ſay upon that ſubject. And hence by the way you may alſo conclude, that the ſulphur and mercury, as they call them, that chymiſts are wont to obtain from compound bodies by the fire, may poſſibly in many caſes be the productions of it; ſince if the ſame bodies had been wrought upon by the agents employed by *Helmont*, they would have yielded neither ſulphur nor mercury; and thoſe portions of them, which the fire would have preſented us in the form of ſulphureous and mercurial bodies, would have, by *Helmont*'s method, been exhibited to us in the form of ſalt.

BUT though (ſays *Eleutherius*) you have alledged very plauſible arguments againſt the *tria prima*, yet I ſee not how it will be poſſible for you to avoid acknowledging, that earth and water are elementary ingredients, though not of mineral concretes, yet of all animal and vegetable bodies; ſince if any of theſe, of what ſort ſoever, be committed to diſtillation, there is regularly and conſtantly ſeparated from it a phlegm or aqueous part, and a *caput mortuum* or earth.

I READILY acknowledge (anſwers *Carneades*) it is not ſo eaſy to reject water and earth (and eſpecially the former) as it is to reject the *tria prima*, from being the elements of mixt bodies; but it is not every difficult thing, that is impoſſible.

I CONSIDER then, as to water, that the chief qualities, which make men give that name to any viſible ſubſtance, are, that it is fluid or liquid, and that it is inſipid and inodorous. Now, as for the taſte of theſe qualities, I think you have never ſeen any of thoſe ſeparated ſubſtances, that the chymiſts call phlegm, which was perfectly devoid both of taſte and ſmell: and if you object, that yet it may be reaſonably ſuppoſed, that ſince the whole body is liquid, the maſs is nothing but elementary water faintly imbued with ſome of the ſaline or ſulphureous parts of the ſame concrete, which it retained with it upon its ſeparation from the other

* *Omne autem alcali addita pinguedine in aqueum liquorem, qui tandem mera & ſimplex aqua fit, reducitur, (ut videre eſt in ſapone, lazurio lapide, &c.) quoties per adjuncta fixa ſemen pinguedinis deponit.* Helmont.

other ingredients: To this I anſwer, that this objection would not appear ſo ſtrong as it is plauſible, if chymiſts underſtood the nature of fluidity and compactneſs; and that, as I formerly obſerved, to a body's being fluid there is nothing neceſſary, but that it be divided into parts ſmall enough; and that theſe parts be put into ſuch a motion among themſelves, as to glide ſome this way, and ſome that way, along each other's ſurfaces. So that although a concrete were never ſo dry, and had not any water or other liquor in-exiſtent in it, yet ſuch a comminution of its parts may be made, by the fire or other agents, as to turn a great portion of them into liquor. Of this truth I will give an inſtance, employed by our friend here preſent, as one of the moſt conducive of his experiments to illuſtrate the nature of ſalts. If you take, then, ſea-ſalt, and melt it in the fire, to free it from the aqueous parts, and afterwards diſtil it with a vehement fire from burnt clay, or any other, as dry a *caput mortuum* as you pleaſe, you will, as chymiſts confeſs by teaching it, drive over a good part of the ſalt in the form of a liquor. And to ſatisfy ſome ingenious men, that a great part of this liquor was ſtill true ſea-ſalt, brought by the operation of the fire into corpuſcles ſo ſmall, and perhaps ſo advantageouſly ſhaped, as to be capable of the form of a fluid body, he did in my preſence pour to ſuch ſpiritual ſalts a due proportion of the ſpirit (or ſalt and phlegm) of urine, whereby having evaporated the ſuperfluous moiſture, he ſoon obtained ſuch another concrete, both as to taſte and ſmell, and eaſy ſublimableneſs, as common ſalt armoniack, which you know is made up of groſs and undiſtilled ſea-ſalt, united with the ſalts of urine and of ſoot, which too are very near of kin to each other. And further, to manifeſt, that the corpuſcles of ſea-ſalt and the ſaline ones of the urine retain their ſeveral natures in this concrete, he mixt it with a convenient quantity of ſalt of tartar, and committing it to diſtillation, ſoon regained his ſpirit of urine in a liquid form by itſelf, the ſea-ſalt ſtaying behind with the ſalt of tartar. Wherefore it is very poſſible, that dry bodies may by the fire be reduced to liquors without any ſeparation of elements, but barely by a certain kind of diſſipation and comminution of the matter, whereby its parts are brought into a new ſtate. And if it be ſtill objected, that the phlegm of mixt bodies muſt be reputed water, becauſe ſo weak a taſte needs but a very ſmall proportion of ſalt to impart it; it may be replied, that, for aught appears, common ſalt and divers other bodies, though they be diſtilled never ſo dry, and in never ſo cloſe veſſels, will yield each of them pretty ſtore of a liquor, wherein though (as I lately noted) ſaline corpuſcles abound, yet there is beſides a large proportion of phlegm, as may eaſily be diſcovered by coagulating the ſaline corpuſcles with any convenient body; as I lately told you, our friend coagulated part of the ſpirit of ſalt with ſpirit of urine; and as I have divers times ſeparated a ſalt from oil of vitriol itſelf (though a very ponderous liquor, and drawn from a ſaline body) by boiling it with a juſt quantity of mercury, and then waſhing the newly coagulated ſalt from the precipitate with fair water. Now to what can we more probably aſcribe this plenty of aqueous ſubſtance afforded us by the diſtillation of ſuch bodies, than unto this, that among the various operations of the fire upon the matter of a concrete, divers particles of that matter are reduced to ſuch a ſhape and bigneſs, as is requiſite to compoſe ſuch a liquor, as chymiſts are wont to call phlegm or water? How I conjecture this change may be effected, it is neither neceſſary for me to tell you, nor poſſible to do ſo without a much longer diſcourſe than were now ſeaſonable. But I deſire you would, with me, reflect upon what I formerly told you, concerning the change of quick-ſilver into water; for that water having but a very faint taſte, if any whit more than divers of thoſe liquors, that chymiſts refer to phlegm, by that experiment it ſeems evident, that even a metalline body, and therefore much more ſuch as are but vegetable or animal, may by a ſimple operation of the fire be turned in great part into water. And ſince thoſe I diſpute with are not yet able out of gold, or ſilver, or divers other concretes, to ſeparate any thing like water; I hope I may be allowed to conclude againſt them, that water itſelf is not an univerſal and pre-exiſtent ingredient of mixt bodies.

BUT as for thoſe chymiſts, that, ſuppoſing with me the truth of what *Helmont* relates of the alkaheſt's wonderful effects, have a right to preſs me with his authority concerning them, and to alledge, that he could tranſmute all reputed mixt bodies into inſipid and mere water; to thoſe I ſhall repreſent, that though his affirmations conclude ſtrongly againſt the vulgar chymiſts (againſt whom I have not therefore ſcrupled to employ them) ſince they evince, that the commonly reputed principles or ingredients of things are not permanent and indeſtructible, ſince they may be further reduced into inſipid phlegm differing from them all; yet till we can be allowed to examine this liquor, I think it not unreaſonable to doubt whether it be not ſomething elſe than mere water. For I find not any other reaſon given by *Helmont* of his pronouncing it ſo, than that it is inſipid. Now ſapour being an accident or an affection of matter, that relates to our tongue, palate, and other organs of taſte, it may very poſſibly be, that the ſmall parts of a body may be of ſuch a ſize and ſhape, as either by their extreme littleneſs, or by their ſlenderneſs, or by their figure, to be unable to pierce into and make perceptible impreſſion upon the nerves or membranous parts of the organs of taſte, and yet may be fit to work otherwiſe upon divers other bodies than mere water can, and conſequently to diſcloſe itſelf to be of a nature far enough from elementary. In ſilk dyed red or of any other colour, whilſt many contiguous threads make up a ſkein, the colour of the ſilk is conſpicuous; but if only a very few of them be looked upon, the colour will appear much fainter than before. But if you take out one ſimple thread, you ſhall not eaſily be able to

diſcern any colour at all; ſo ſubtile an object having not the force to make upon the optick nerve an impreſſion great enough to be taken notice of. It is alſo obſerved, that the beſt ſort of oil-olive is almoſt taſteleſs; and yet I need not tell you how exceedingly diſtant in nature oil is from water. The liquor, into which I told you, upon the relation of *Lully* an eye-witneſs, that mercury might be tranſmuted, has ſometimes but a very languid, if any taſte; and yet its operations, even upon ſome mineral bodies, are very peculiar. Quickſilver itſelf alſo, though the corpuſcles it conſiſts of be ſo very ſmall, as to get into the pores of that cloſeſt and compacteſt of bodies, gold, is yet (you know) altogether taſteleſs. And our *Helmont* ſeveral times tells us, that fair water, wherein a little quantity of quickſilver has lain for ſome time, though it acquire no certain taſte or other ſenſible quality from the quick-ſilver; yet it has a power to deſtroy worms in human bodies; which he does much, but not cauſeleſsly extol. And I remember, a great lady, that had been eminent for her beauty in divers courts, confeſſed to me, that this inſipid liquor was of all innocent waſhes for the face the beſt, that ſhe ever met with.

AND here let me conclude my diſcourſe, concerning ſuch waters or liquors as I have hitherto been examining, with theſe two conſiderations. Whereof the firſt is, that by reaſon of our being wont to drink nothing but wine, beer, cyder, or other ſtrongly taſted liquors, there may be in ſeveral of thoſe liquors, that are wont to paſs for inſipid phlegm, very peculiar and diſtinct taſtes, though unheeded (and perhaps not to be perceived) by us. For to omit what naturaliſts affirm of apes, (and which probably may be true of divers other animals) that they have a more exquiſite palate than men; among men themſelves, thoſe, that are wont to drink nothing but water, may (as I have tried in my ſelf) diſcern very ſenſibly a great difference of taſtes in ſeveral waters, which one unaccuſtomed to drink water would take to be all alike inſipid. And this is the firſt of my two conſiderations. The other is, that it is not impoſſible, that the corpuſcles, into which a body is diſſipated by the fire, may by the operation of the ſame fire have their figures ſo altered, or may be by aſſociations with one another brought into little maſſes of ſuch a ſize and ſhape, as not to be fit to make ſenſible impreſſions on the tongue. And that you may not think ſuch alterations impoſſible, be pleaſed to conſider with me, that not only the ſharpeſt ſpirit of vinegar having diſſolved as much coral as it can, will coagulate with it into a ſubſtance, which, though ſoluble in water like ſalt, is incomparably leſs ſtrongly taſted than the vinegar was before; but (what is more conſiderable) though the acid ſalts, that are carried up with quickſilver, in the preparation of common ſublimate, are ſo ſharp, that being moiſtened with water it will corrode ſome of the metals themſelves; yet this corroſive ſublimate being twice or thrice re-ſublimed with a full proportion of inſipid quickſilver, conſtitutes (as you know) that factitious concrete, which the chymiſts call *mercurius dulcis*; not becauſe it is ſweet, but becauſe the ſharpneſs of the corroſive ſalts is ſo taken away by their combination with the mercurial corpuſcles, that the whole mixture, when it is prepared, is judged to be inſipid.

AND thus (continues *Carneades*) having given you ſome reaſons, why I refuſe to admit elementary water for a conſtant ingredient of mixt bodies, it will be eaſy for me to give you an account, why I alſo reject earth.

FOR firſt, it may well be ſuſpected, that many ſubſtances paſs among chymiſts under the name of earth, becauſe, like it, they are dry, and heavy, and fixt; which yet are very far from an elementary nature. This you will not think improbable, if you recall to mind what I formerly told you concerning what chymiſts call the dead earth of things, and eſpecially touching the copper to be drawn from the *caput mortuum* of vitriol; and if alſo you allow me to ſubjoin a caſual, but memorable experiment, made by *Joannes Agricola* upon the *terra damnata* of brimſtone. Our author then tells us (in his notes upon *Popius*) that in the year 1621 he made an oil of ſulphur; the remaining fæces he reverberated in a moderate fire fourteen days; afterwards he put them well luted up in a wind oven, and gave them a ſtrong fire for ſix hours, purpoſing to calcine the fæces to a perfect whiteneſs, that he might make ſomething elſe out of them. But coming to break the pot, he found above but very little fæces, and thoſe grey and not white; but beneath there lay a fine red regulus, which he firſt marvelled at, and knew not what to make of, being well aſſured, that not the leaſt thing, beſides the fæces of the ſulphur, came into the pot; and that the ſulphur it ſelf had only been diſſolved in linſeed-oil. This regulus he found heavy and malleable almoſt as lead; having cauſed a goldſmith to draw him a wire of it, he found it to be of the faireſt copper, and ſo rightly coloured, that a Jew of *Prague* offered him a great price for it. And of this metal he ſays he had twelve *loth* (or ſix ounces) out of one pound of aſhes or fæces. And this ſtory may well incline us to ſuſpect, that ſince the *caput mortuum* of the ſulphur was kept ſo long in the fire, before it was found to be any thing elſe than a *terra damnata*, there may be divers other reſidences of bodies, which are wont to paſs only for the terreſtrial fæces of things, and therefore to be thrown away, as ſoon as the diſtillation or calcination of the body that yielded them is ended; which yet, if they were long and ſkilfully examined by the fire, would appear to be differing from elementary earth. And I have taken notice of the unwarrantable forwardneſs of common chymiſts to pronounce things uſeleſs fæces, by obſerving how often they reject the *caput mortuum* of verdigreaſe; which is yet ſo far from deſerving that name, that not only by ſtrong fires, and convenient additaments, it may in ſome hours be reduced into copper, but with a certain flux powder I ſometimes make for recreation, I have in two or three minutes obtained that metal from it. To which

I may add, that having for trial's ſake kept Venetian talc in no leſs a heat than that of a glaſs-furnace, I found, after all the brunt of the fire it had indured, the remaining body, though brittle and diſcoloured, had not loſt very much of its former bulk, and ſeemed ſtill to be nearer of kin to talc, than to meer earth. And I remember too, that a candid mineraliſt, famous for his ſkill in trying of ores, requeſting me one day to procure him a certain American mineral earth of a virtuoſo, who, he thought, would not refuſe me; I inquired of him, why he ſeemed ſo greedy of it: he confeſſed to me, that this gentleman having brought that earth to the publick ſay-maſters; and upon their being unable by any means to bring it to fuſion, or make it fly away, he (the relator) had procured a little of it; and having tried it with a peculiar flux, ſeparated from it near a third part of pure gold; ſo great miſtakes may be committed in haſtily concluding things to be uſeleſs earth.

NEXT, it may be ſuppoſed, that as in the reſolution of bodies by the fire, ſome of the diſſipated parts may, by their various occurſion occaſioned by the heat, be brought to ſtick together ſo cloſely, as to conſtitute corpuſcles too heavy for the fire to carry away; the aggregate of which corpuſcles is wont to be called aſhes of earth; ſo other agents may reſolve the concrete into minute parts after ſo differing a manner, as not to produce any *caput mortuum*, or dry and heavy body. As you may remember *Helmont* above informed us, that with his great diſſolvent he divided a coal into two liquid and volatile bodies equiponderant to the coal, without any dry or fixt reſidence at all.

AND indeed, I ſee not, why it ſhould be neceſſary, that all agents, that reſolve bodies into portions of differing qualified matter, muſt work on them the ſame way, and divide them into juſt ſuch parts, both for nature and number, as the fire diſſipates them into. For ſince, (as I noted before) the bulk and ſhape of the ſmall parts of bodies, together with their fitneſs and unfitneſs to be eaſily put into motion, may make the liquors, or other ſubſtances ſuch corpuſcles compoſe, as much to differ from each other, as do ſome of the chymical principles: why may not ſomething happen in this caſe, not unlike what is uſual in the groſſer diviſions of bodies by mechanical inſtruments? where we ſee, that ſome tools reduce wood, for inſtance, into parts of ſeveral ſhapes, bigneſs, and other qualities, as hatchets and wedges divide it into groſſer parts; ſome more long and ſlender, as ſplinters; and ſome more thick and irregular, as chips; but all of conſiderable bulk: but files and ſaws make a comminution of it into duſt; which, as all the others, is of the more ſolid ſort of parts; whereas others divide it into long and broad, but thin and flexible parts, as do planes. And of this kind of parts it ſelf there is alſo a variety, according to the difference of the tools employed to work on the wood; the ſhavings made by the plane being in ſome things differing from thoſe ſhives or thin and flexible pieces of wood, that are obtained by borers, and theſe from ſome others obtainable by other tools. Some chymical examples applicable to this purpoſe I have elſewhere given you. To which I may add, that whereas, in a mixture of ſulphur and ſalt of tartar well melted and incorporated together, the action of pure ſpirit of wine digeſted on it is to ſeparate the ſulphureous from the alcalizate parts, by diſſolving the former, and leaving the latter, the action of wine (probably upon the ſcore of its copious phlegm) upon the ſame mixture, is to divide it into corpuſcles conſiſting of both alcalizate and ſulphureous parts united. And if it be objected, that this is but a factitious concrete; I anſwer, that however the inſtance may ſerve to illuſtrate what I propoſed, if not to prove it; and that nature her ſelf doth in the bowels of the earth make decompounded bodies, as we ſee in vitriol, cinnabar, and even in ſulphur it ſelf; I will not urge, that the fire divides new milk into five differing ſubſtances; but rennet and acid liquors divide it into a coagulated matter and a thin whey: and on the other ſide, churning divides it into butter and butter-milk, which may either of them yet be reduced to other ſubſtances differing from the former. I will not preſs this, I ſay, nor other inſtances of this nature, becauſe I cannot in few words anſwer what may be objected, that theſe concretes ſequeſtered without the help of the fire may by it be further divided into hypoſtatical principles. But I will rather repreſent, that whereas the ſame ſpirit of wine will diſſociate the parts of camphire, and make them one liquor with it ſelf; aqua fortis will alſo disjoin them, and put them into motion; but ſo as to keep them together, and yet alter their texture into the form of an oil. I know alſo an uncompounded liquor, that an extraordinary chymiſt would not allow to be ſo much as ſaline, which doth (as I have tried) from coral it ſelf (as fixt as divers judicious writers aſſert that concrete to be) not only obtain a noble tincture, without the intervention of nitre or other ſalts, but will carry over the tincture in diſtillation. And if ſome reaſons did not forbid me, I could now tell you of a menſtruum I make my ſelf, that doth more oddly diſſociate the parts of minerals very fixt in the fire. So that it ſeems not incredible, that there may be ſome agent or way of operation found, whereby this or that concrete, if not all firm bodies, may be reſolved into parts ſo very minute and ſo apt to ſtick cloſe to one another, that none of them may be fixt enough to ſtay behind in a ſtrong fire, and to be incapable of diſtillation; nor conſequently to be looked upon as earth. But to return to *Helmont*, the ſame author ſomewhere ſupplies me with another argument againſt the earth's being ſuch an element, as my adverſaries would have it. For he ſomewhere affirms, that he can reduce all the terreſtrial parts of mixt bodies into inſipid water; whence we may argue againſt the earth's being one of their elements, even from that notion of elements, which you may remember *Philoponus* recited out of *Ariſtotle* himſelf, when he lately diſputed for his chy-

miſts againſt *Themiſtius*. And here we may on this occaſion conſider, that ſince a body, from which the fire hath driven away its looſer parts, is wont to be looked upon as earth, upon the account of its being endowed with both theſe qualities, taſtleſſneſs and fixedneſs, (for ſalt of tartar, though fixed, paſſes not among the chymiſts for earth, becauſe it is ſtrongly taſted) if it be in the power of natural agents to deprive the *caput mortuum* of a body of either of thoſe two qualities, or to give them both to a portion of matter, that had them not both before, the chymiſts will not eaſily define what part of a reſolved concrete is earth, and make out, that that earth is a primary, ſimple, and indeſtructible body. Now there are ſome caſes, wherein the more ſkilful of the vulgar chymiſts themſelves pretend to be able, by repeated cohobations, and other fit operations, to make the diſtilled parts of a concrete bring its own *caput mortuum* over the helm, in the form of a liquor; in which ſtate being both fluid and volatile, you will eaſily believe it would not be taken for earth. And indeed by a ſkilful, but not vulgar, way of managing ſome concretes, there may be more effected in this kind, than you perhaps would eaſily think. And on the other ſide, that either earth may be generated, or at leaſt bodies, that did not before appear to be near totally earth, may be ſo altered as to paſs for it, ſeems very poſſible, if * *Helmont* have done that by art, which he mentions in ſeveral places; eſpecially where he ſays, that he knows ways, whereby ſulphur once diſſolved is all of it fixed into a terreſtrial powder, and the whole body of ſalt-petre may be turned into earth: which laſt he elſewhere ſays is done by the odour only of a certain ſulphureous fire. And in another place he mentions one way of doing this, which I cannot give you an account of; becauſe the materials I had prepared for trying it, were by a ſervant's miſtake unhappily thrown away.

AND, theſe laſt arguments may be confirmed by the experiment I have often had occaſion to mention, concerning the mint I produced out of water. And partly by an obſervation of *Rondeletius* concerning the growth of animals alſo, nouriſhed but by water, which I remembered not to mention, when I diſcourſed to you about the production of things out of water. This diligent writer then, in his inſtructive book of fiſhes, affirms that his wife kept a fiſh in a glaſs of water without any other food for three years; in which ſpace it was conſtantly augmented, till at laſt it could not come out of the place, at which it was put in, and at length was too big for the glaſs it ſelf, though that were of a large capacity. And becauſe there is no juſt reaſon to doubt, that this fiſh, if diſtilled, would have yielded the like differing ſubſtances with other animals; and however, becauſe the mint, which I had out of water, afforded me upon diſtillation a good quantity of charcoal; I think I may from thence infer, that earth it ſelf may be produced out of water; or if you pleaſe, that water may be tranſmuted into earth: and conſequently, that though it could be proved, that earth is an ingredient actually in-exiſtent in the vegetable and animal bodies, whence it may be obtained by fire; yet it would not neceſſarily follow, that earth, as a pre-exiſtent element, does with other principles convene to make up thoſe bodies, whence it ſeems to have been ſeparated.

Lib. 1. cap. 2.

AFTER all is ſaid (ſays *Eleutherius*) I have yet ſomething to object, that I cannot but think conſiderable, ſince *Carneades* himſelf alledged it as ſuch; for, (continues *Eleutherius* ſmiling) I muſt make bold to try, whether you can as luckily anſwer your own arguments, as thoſe of your antagoniſts; I mean (purſues he) that part of your conceſſions, wherein you cannot but remember, that you ſupplied your adverſaries with an example to prove, that there may be elementary bodies, by taking notice, that gold may be an ingredient in a multitude of differing mixtures, and yet retain its nature, notwithſtanding all that the chymiſts by their fires and corroſive waters are able to do to deſtroy it.

I SUFFICIENTLY intimated to you at that time (replies *Carneades*) that I propoſed this example, chiefly to ſhew you, how nature may be conceived to have made elements, not to prove, that ſhe actually has made any; and you know, that *à poſſe ad eſſe* the inference will not hold. But (continues *Carneades*) to anſwer more directly to the objection drawn from gold, I muſt tell you, that though I know very well, that divers of the more ſober chymiſts have complained of the vulgar chymiſts, as of mountebanks or cheats, for pretending ſo vainly, as hitherto they have done, to deſtroy gold; yet I know a certain menſtruum (which our friend has made, and intends ſhortly to communicate to the ingenious) of ſo piercing and powerful a quality; that if notwithſtanding much care, and ſome ſkill, I did not much deceive my ſelf, I have with it really deſtroyed even refined gold, and brought it into a metalline body of another colour and nature, as I found by trials purpoſely made. And if ſome juſt conſiderations did not for the preſent forbid it, I could perchance here ſhew you by another experiment or two of my own trying, that ſuch menſtruums may be made, as to entice away and retain divers parts from bodies, which even the more judicious and experienced Spagyriſts have pronounced irreſoluble by the fire; though (which I deſire you would mark) in neither of theſe inſtances, the gold or precious ſtones be analyſed into any of the *tria prima*, but only reduced to new concretes. And indeed there is a great diſparity betwixt the operations of the ſeveral agents, whereby the parts of a body come to be diſſipated. As if (for inſtance) you diſſolve the purer ſort of vitriol in common water, the liquor will ſwallow up the mineral, and ſo diſſociate its corpuſcles, that they will ſeem to make up but one liquor with thoſe of the water; and yet each of theſe corpuſcles retains its nature

* *Novi item modos, quibus totum ſal-petræ in terram convertitur, totumque ſulphur ſemel diſſolutum fixetur in pulverem terreum.* Helmont. in Compl. atque Miſt. Elementor. ſect. 24.

nature and texture, and remains a vitriolate and compounded body. But if the ſame vitriol be expoſed to a ſtrong fire, it will then be divided, not only, as before, into ſmaller parts, but into heterogeneous ſubſtances, each of the vitriolate corpuſcles, that remained entire in the water, being it ſelf upon the deſtruction of its former texture diſſipated or divided into new particles of differing qualities. But inſtances more fitly applicable to this purpoſe I have already given you. Wherefore to return to what I told you about the deſtruction of gold; that experiment invites me to repreſent to you, that though there were either ſaline, or ſulphureous, or terreſtrial portions of matter, whoſe parts were ſo ſmall, ſo firmly united together, or of a figure ſo fit to make them cohere to one another, (as we ſee, that in quickſilver, broken into little globes, the parts brought to touch one another do immediately re-imbody) that neither the fire, nor the uſual agents, employed by chymiſts, are piercing enough to divide their parts, ſo as to deſtroy the texture of the ſingle corpuſcles; yet it would not neceſſarily follow, that ſuch permanent bodies were elementary; ſince it is poſſible, there may be agents found in nature, ſome of whoſe parts may be of ſuch a ſize and figure, as to take better hold of ſome parts of theſe ſeemingly elementary corpuſcles, than theſe parts do of the reſt; and conſequently may carry away ſuch parts with them, and ſo diſſolve the texture of the corpuſcle by pulling its parts aſunder. And if it be ſaid, that at leaſt we may this way diſcover the elementary ingredients of things, by obſerving into what ſubſtances theſe corpuſcles, that were reputed pure, are divided; I anſwer, that it is not neceſſary, that ſuch a diſcovery ſhould be practicable. For if the particles of the diſſolvent do take ſuch firm hold of thoſe of the diſſolved body, they muſt conſtitute together new bodies, as well as deſtroy the old; and the ſtrict union, which, according to this hypotheſis, may well be ſuppoſed betwixt the parts of the emergent bodies will make it as little to be expected, that they ſhould be pulled aſunder, but by little parts of matter, that to divide them, aſſociate themſelves, and ſtick extremely cloſe to thoſe of them, which they ſever from their former adherents. Beſides that it is not impoſſible, that a corpuſcle, ſuppoſed to be elementary, may have its nature changed, without ſuffering a divorce of its parts, barely by a new texture effected by ſome powerful agent; as I formerly told you, the ſame portion of matter may eaſily, by the operation of the fire, be turned at pleaſure into the form of a brittle and tranſparent, or an opacous and malleable body.

AND indeed, if you conſider how far the bare change of texture, whether made by art or nature (or rather by nature with or without the aſſiſtance of man) can go in producing ſuch new qualities in the ſame parcel of matter, and how many inanimate bodies (ſuch as are all the chymical productions of the fire) we know are denominated and diſtinguiſhed, not ſo much by any imaginary ſubſtantial form, as by the aggregate of theſe qualities; if you conſider theſe things, I ſay, and that the varying of either figure, or the ſize, or the motion, or the ſituation, or connexion of the corpuſcles whereof any of theſe bodies is compoſed, may alter the fabrick of it, you will poſſibly be invited to ſuſpect with me, that there is no great need, that nature ſhould always have elements before-hand, whereof to make ſuch bodies as we call mixts. And that it is not ſo eaſy as chymiſts and others have hitherto imagined, to diſcern, among the many differing ſubſtances, that may without any extraordinary ſkill be obtained from the ſame portion of matter, which ought to be eſteemed, excluſively to all the reſt, its in-exiſtent elementary ingredients, much leſs to determine, what primogeneal and ſimple bodies convened together to compoſe it. To exemplify this, I ſhall add, to what I have already on ſeveral occaſions repreſented, but this ſingle inſtance:

YOU may remember (*Eleutherius*) that I formerly intimated to you, that beſides mint and pompions, I produced divers other vegetables of very differing natures out of water. Wherefore you will not, I preſume, think it incongruous to ſuppoſe, that when a ſlender vine-ſlip is ſet into the ground, and takes root there, it may likewiſe receive its nutriment from the water attracted out of the earth by its roots, or impelled by the warmth of the ſun, or preſſure of the ambient air into the pores of them. And this you will the more eaſily believe, if you ever obſerved, what a ſtrange quantity of water will drop out of a wound given to the vine, in a convenient place, at a ſeaſonable time in the ſpring; and how little of taſte or ſmell this aqua vita, as phyſicians call it, is endowed with, notwithſtanding what concoction or alteration it may receive in its paſſage through the vine, to diſcriminate it from common water. Suppoſing then this liquor, at its firſt entrance into the roots of the vine, to be common water; let us a little conſider, how many various ſubſtances may be obtained from it; though, to do ſo, I muſt repeat ſomewhat, that I had a former occaſion to touch upon. And firſt, this liquor being digeſted in the plant, and aſſimilated by the ſeveral parts of it, is turned into the wood, bark, pith, leaves, *&c.* of the vine; the ſame liquor may be further dried, and faſhioned into vine-buds, and theſe a while after are advanced unto four grapes, which expreſſed yield verjuice, a liquor very differing in ſeveral qualities both from wine and other liquors obtainable from the vine: theſe four grapes, being by the heat of the ſun concocted and ripened, turn to well taſted grapes; theſe, if dried in the ſun and diſtilled, afford a fœtid oil and a piercing empyreumatical ſpirit, but not a vinous ſpirit; theſe dried grapes or raiſins, boiled in a convenient proportion of water, make a ſweet liquor, which, being betimes diſtilled, afford an oil and ſpirit much like thoſe of the raiſins themſelves; if the juice of the grapes be ſqueezed out, and put to ferment, it firſt becomes a ſweet and turbid liquor, then grows leſs ſweet and more clear, and then affords

affords in common diſtillations not an oil, but a ſpirit, which, though inflammable like oil, differs much from it, in that it is not fat, and that it will readily mingle with water. I have likewiſe without addition obtained in proceſs of time (and by an eaſy way, which I am ready to teach you) from one of the nobleſt ſorts of wine, pretty ſtore of pure and curiouſly figured cryſtals of ſalt, together with a great proportion of a liquor as ſweet almoſt as honey; and theſe I obtained not from muſt, but true and ſprightly wine; beſides the vinous liquor, the fermented juice of grapes is partly turned into liquid drops or lees, and partly into that cruſt or dry feculency, that is commonly called tartar; and this tartar may by the fire be caſily divided into five differing ſubſtances; four of which are not acid, and the other not ſo manifeſtly acid as the tarter it ſelf. The ſame vinous juice, after ſome time, eſpecially if it be carefully kept, degenerates into that very ſour liquor called vinegar; from which you may obtain by the fire a ſpirit and a cryſtalline ſalt, differing enough from the ſpirit and lixiviate ſalt of tartar. And if you pour the dephlegmed ſpirit of the vinegar upon the ſalt of tartar, there will be produced ſuch a conflict or ebullition, as if there were ſcarce two more contrary bodies in nature; and oftentimes in this vinegar you may obſerve part of the matter to be turned into an innumerable company of ſwimming animals; which our friend having divers years ago obſerved, hath in one of his papers taught us, how to diſcover clearly without the help of a miſcroſcope.

INTO all theſe various ſchemes of matter, or differingly-qualified bodies, beſides divers others, that I purpoſely forbear to mention, may the water, that is imbibed by the roots of the vine, be brought; partly by the formative power of the plant, and partly by ſupervenient agents or cauſes, without the viſible concurrence of any extraneous ingredient. But if we be allowed to add to the productions of this tranſmuted water a few other ſubſtances, we may much increaſe the variety of ſuch bodies; although in this ſecond ſort of productions, the vinous parts ſeem ſcarce to retain any thing of the much more fixed bodies, wherewith they were mingled, but only to have, by their mixture with them, acquired ſuch a diſpoſition, that in their receſs, occaſioned by the fire, they came to be altered as to ſhape, or bigneſs, or both, and aſſociated after a new manner. Thus, as I formerly told you, I did, by the addition of a *caput mortuum* of antimony, and ſome other bodies unfit for diſtillation, obtain from crude tartar ſtore of a very volatile and cryſtalline ſalt, differing very much in ſmell and other qualities from the uſual ſalts of tartar.

BUT (ſays *Eleutherius*, interrupting him at theſe words) if you have no reſtraint upon you, I would very gladly, before you go any further, be more particularly informed, how you make this volatile ſalt; becauſe, you know, that ſuch multitudes of chymiſts have, by a ſcarce imaginable variety of ways, attempted in vain the volatilization of the ſalt of tartar, that divers learned Spagyriſts ſpeak, as if it were impoſſible to make any thing out of tartar, that ſhall be volatile in a ſaline form, or, as ſome of them expreſs it, *in forma ſicca*. I am very far from thinking (anſwers *Carneades*) that the ſalt I have mentioned is that, which *Paracelſus* and *Helmont* mean, when they ſpeak of *ſal tartari volatile*, and aſcribe ſuch great things to it. For the ſalt I ſpeak of falls extremely ſhort of thoſe virtues, not ſeeming in its taſte, ſmell, and other obvious qualities, to differ very much (though ſomething it does differ) from ſalt of hartſhorn, and other volatile ſalts drawn from the diſtilled parts of animals. Nor have I yet made trials enough to be ſure, that it is a pure ſalt of tartar, without participating any thing at all of the nitre, or antimony. But becauſe it ſeems more likely to proceed from the tartar, than from any of the other ingredients, and becauſe the experiment is in itſelf not ignoble, and luciferous enough, (as ſhewing a new way to produce a volatile ſalt, contrary to acid ſalts, from bodies, that otherwiſe are obſerved to yield no ſuch liquor, but either only, or chiefly, acid ones;) I ſhall, to ſatisfy you, acquaint you, before any of my other friends, with the way I now uſe (for I have formerly uſed ſome others) to make it.

TAKE then, of good antimony, ſalt-petre, and tartar, of each an equal weight, and of quick-lime half the weight of any one of them; let theſe be powdered and well mingled. This done, you muſt have in readineſs a long neck or retort of earth, which muſt be placed in a furnace for a naked fire, and have at the top of it a hole of a convenient bigneſs, at which you may caſt in the mixture, and preſently ſtop it up again. This veſſel being fitted with a large receiver, muſt have fire made under it, till the bottom of the ſides be red hot, and then you muſt caſt in the above prepared mixture, by about half a ſpoonful (more or leſs) at a time, at the hole made for that purpoſe; which being nimbly ſtopt, the fumes will paſs into the receiver, and condenſe there into a liquor, that being rectified will be of a pure golden colour, and carry up that colour to a great height. This ſpirit abounds in the ſalt I told you of, part of which may eaſily enough be ſeparated by the way I uſe in ſuch caſes, which is, to put the liquor into a glaſs egg, or bolt-head with a long and narrow neck. For if this be placed a little inclining in hot ſand, there will ſublime up a fine ſalt, which, as I told you, I find to be much of kin to the volatile ſalts of animals: for like them it has a ſaltiſh, not an acid ſalt; it hiſſes upon the affuſion of ſpirit of nitre, or oil of vitriol; it precipitates corals diſſolved in ſpirit of vinegar; it turns the blue ſyrup of violets immediately green; it preſently turns the ſolution of ſublimate into a milky whiteneſs; and in ſum, has divers operations like thoſe, that I have obſerved in that ſort of ſalts, to which I have reſembled it; and is ſo volatile, that, for diſtinction-ſake, I call it *ſal tartari fugitivus*. What virtues it may have in phyſick, I have not yet had the opportunity to try; but I am apt to think they will not be deſpicable. And beſides that, a very

very ingenious friend of mine tells me, he hath done great matters againſt the ſtone with a preparation not very much differing from ours; a very experienced German chymiſt finding, that I was unacquainted with the ways of making this ſalt, told me, that in a great city in his country, a noted chymiſt prizes it ſo highly, that he had a while ſince procured a privilege from the magiſtrates, that none but he, or by his licence, ſhould vend a ſpirit made almoſt after the ſame way with mine, ſave that he leaves out one of the ingredients, namely the quick-lime. But (continues *Carneades*) to reſume my former diſcourſe, where your curioſity interrupted it;

IT is alſo a common practice in *France* to bury thin plates of copper in the marc (as the French call it) or huſks of grapes, whence the juice hath been ſqueezed out in the vine-preſs; and by this means the more ſaline parts of thoſe huſks, working by little and little upon the copper, coagulate themſelves with it into that blueiſh green ſubſtance we in Engliſh call verdigreaſe. Of which I therefore take notice, becauſe having diſtilled it in a naked fire, I found, as I expected, that by the aſſociation of the ſaline with the metalline parts, the former were ſo altered, that the diſtilled liquor, even without rectification, ſeemed by ſmell and taſte, ſtrong almoſt like aqua fortis, and very much ſurpaſſed the pureſt and moſt rectified ſpirit of vinegar, that ever I made. And this ſpirit I therefore aſcribe to the ſalt of the huſks altered by their co-mixture with the copper (though the fire afterwards divorce and tranſmute them) becauſe I found this latter in the bottom of the retort in the form of a crocus or reddiſh powder; and becauſe copper is of too ſluggiſh a nature to be forced over in cloſe veſſels by no ſtronger a heat. And that, which is alſo ſomewhat remarkable in the diſtillation of good verdigreaſe, (or at leaſt of that ſort that I uſed) is this, that I never could obſerve, that it yielded me any oil, (unleſs a little black ſlime, which was ſeparated in rectification may paſs for oil) though both tartar and vinegar (eſpecially the former) will by diſtillation yeld a moderate proportion of it. If likewiſe you pour ſpirit of vinegar upon calcined lead, the acid ſalt of the liquor will by its commixture with the metalline parts, though inſipid, acquire in few hours a more than ſaccharine ſweetneſs; and theſe ſaline parts being by a ſtrong fire diſtilled from the lead, wherewith they were imbodied, will, as I formerly alſo noted to a different purpoſe, leave the metal behind them altered in ſome qualities from what it was, and will themſelves aſcend, partly in the form of an unctuous body or oil, partly in that of phlegm, but for the greateſt part in the form of a ſubtile ſpirit, indowed, beſides divers new qualities, which I am not now willing to take notice of, with a ſtrong ſmell very much other than that of vinegar, and a piercing taſte quite differing both from the ſourneſs of the ſpirit of vinegar, and the ſweetneſs of the ſugar of lead.

TO be ſhort, as the difference of bodies may depend meerly upon that of the ſchemes, whereinto their common matter is put; ſo the ſeeds of things, the fire and the other agents are able to alter the minute parts of a body (either by breaking them into ſmaller ones of differing ſhapes, or by uniting together theſe fragments with the unbroken corpuſcles, or ſuch corpuſcles among themſelves) and the ſame agents, partly by altering the ſhape or bigneſs of the conſtituent corpuſcles of a body, partly by driving away ſome of them, partly by blending others with them, and partly by ſome new manner of connecting them, may give the whole portion of matter a new texture of its minute parts, and thereby make it deſerve a new and diſtinct name. So that, according as the ſmall parts of matter recede from each other, or work upon each other, or are connected together after this or that determinate manner, a body of this or that denomination is produced, as ſome other body happens thereby to be altered or deſtroyed.

SINCE then thoſe things, which chymiſts produce by the help of the fire, are but inanimate bodies; ſince ſuch fruits of the chymiſts ſkill differ from one another but in ſo few qualities, that we ſee plainly, that by fire, and other agents we can employ, we can eaſily enough work as great alterations upon matter, as thoſe, that are requiſite to change one of theſe chymical productions into another; ſince the ſame portion of matter may, without being compounded with any extraneous body, or at leaſt element, be made to put on ſuch a variety of forms, and conſequently to be (ſucceſſively) turned into ſo many differing bodies; and ſince the matter, cloathed with ſo many differing forms, was originally but water, and that in its paſſage through ſo many transformations, it was never reduced into any of thoſe ſubſtances, which are reputed to be the principles or elements of mixt bodies, except the violence of the fire, which it ſelf divides not bodies into perfectly ſimple or elementary ſubſtances, but into new compounds; ſince, I ſay, theſe things are ſo, I ſee not, why we muſt needs believe, that there are any primogeneal and ſimple bodies, of which, as of pre-exiſtent elements, nature is obliged to compound all others. Nor do I ſee, why we may not conceive, that ſhe may produce the bodies accounted mixt out of one another, by variouſly altering and contriving their minute parts, without reſolving the matter into any ſuch ſimple or homogeneous ſubſtances, as are pretended. Neither, to diſpatch, do I ſee, why it ſhould be counted abſurd to think, that when a body is reſolved by the fire into its ſuppoſed ſimple ingredients, thoſe ſubſtances, are not true and proper elements, but rather were, as it were, accidentally produced by the fire, which by diſſipating a body into minute parts does, if thoſe parts be ſhut up in cloſe veſſels, for the moſt part neceſſarily bring them to aſſociate themſelves after another manner than before, and ſo bring them into bodies of ſuch different conſiſtences, as the former texture of the body and concurrent circumſtances make ſuch diſbanded particles apt to conſtitute; as experience ſhews us (and I have both noted it, and proved

it already) that as there are ſome concretes whoſe parts, when diſſipated by fire, are fitted to be put into ſuch ſchemes of matter as we call oil, and ſalt, and ſpirit; ſo there are others, ſuch as are eſpecially the greateſt part of minerals, whoſe corpuſcles being of another ſize or figure, or perhaps contrived another way, will not in the fire yield bodies of the like conſiſtencies, but rather others of differing textures; not to mention, that from gold and ſome other bodies, we ſee not, that the fire ſeparates any diſtinct ſubſtances at all; nor that even thoſe ſimilar parts of bodies, which the chymiſts obtain by the fire, are the elements, whoſe names they bear, but compound bodies, upon which, for their reſemblance to them in conſiſtence, or ſome other obvious quality, chymiſts have been pleaſed to beſtow ſuch appellations.

The CONCLUSION.

THESE laſt words of *Carneades* being ſoon after followed by a noiſe, which ſeemed to come from the place, where the reſt of the company was, he took it for a warning, that it was time for him to conclude or break off his diſcourſe; and told his friend, By this time, I hope, you ſee, *Eleutherius*, that if *Helmont*'s experiments be true, it is no abſurdity to queſtion, whether that doctrine be one, that doth not aſſert any elements in the ſenſe before explained. But becauſe that as divers of my arguments ſuppoſe the marvellous power of the alkaheſt in the analyzing of bodies, ſo the effects aſcribed to that power are ſo unparallelled and ſtupendous, that though I am not ſure, but that there may be ſuch an agent, yet little leſs than αὐτοψία ſeems requiſite to make a man ſure there is. And conſequently I leave it to you to judge, how far thoſe of my arguments, that are built upon alkaheſtical operations, are weakened by that liquor's being matchleſs; and ſhall therefore deſire you not to think, that I propoſe this paradox, that rejects all elements, as an opinion equally probable with the former part of my diſcourſe. For by that, I hope, you are ſatisfied, that the arguments, wont to be brought by chymiſts to prove, that all bodies conſiſt of either three principles, or five, are far from being ſo ſtrong as thoſe, that I have employed to prove, that there is not any certain and determinate number of ſuch principles or elements to be met with univerſally in all mixt bodies. And, I ſuppoſe, I need not tell you, that theſe anti-chymical paradoxes might have been managed more to their advantage; but that having not confined my curioſity to chymical experiments, I, who am but a young man, and younger chymiſt, can yet be but ſlenderly furniſhed with them, in reference to ſo great and difficult a taſk as you impoſed upon me: beſides that, to tell you the truth, I durſt not employ ſome even of the beſt experiments I am acquainted with, becauſe I muſt not yet diſcloſe them. But however, I think I may preſume, that what I have hitherto diſcourſed, will induce you to think, that chymiſts have been much more happy in finding experiments than the cauſes of them; or in aſſigning the principles, by which they may beſt be explained. And indeed, when in the writings of *Paracelſus* I meet with ſuch phantaſtick and unintelligible diſcourſes, as that writer often puzzles and tires his reader with, fathered upon ſuch excellent experiments, as though he ſeldom clearly teaches, I often find he knew; methinks the chymiſts, in their ſearches after truth, are not unlike the navigators of *Solomon*'s *Tarſhiſh* fleet, who brought home from their long and tedious voyages, not only gold, and ſilver, and ivory, but apes and peacocks too: for ſo the writings of ſeveral (for I ſay not, all) of your hermetick philoſophers preſent us, together with divers ſubſtantial and noble experiments, theories, which either like peacocks feathers make a great ſhew, but are neither ſolid nor uſeful; or elſe like apes, if they have ſome appearance of being rational, are blemiſhed with ſome abſurdity or other, that, when they are attentively conſidered, make them appear ridiculous.

CARNEADES having thus finiſhed his diſcourſe againſt the received doctrines of the elements, *Eleutherius* judging he ſhould not have time to ſay much to him before their ſeparation, made ſome haſte to tell him; I confeſs, *Carneades*, that you have ſaid more in favour of your paradoxes than I expected. For though divers of the experiments you have mentioned are no ſecrets, and were not unknown to me; yet beſides that you have added many of your own unto them, you have laid them together in ſuch a way, and applied them to ſuch purpoſes, and made ſuch deductions from them, as I have not hitherto met with.

BUT though I be therefore inclined to think, that *Philoponus*, had he heard you, would ſcarce have been able in all points to defend the chymical hypotheſis againſt the arguments, wherewith you have oppoſed it; yet methinks, that however your objections ſeem to evince a great part of what they pretend to, yet they evince it not all; and the numerous trials of thoſe you call the vulgar chymiſts, may be allowed to prove ſomething too.

WHEREFORE, if it be granted you, that you have made it probable;

FIRST, that the differing ſubſtances, into which mixt bodies are wont to be reſolved by the fire, are not of a pure and an elementary nature, eſpecially for this reaſon, that they yet retain ſo much of the nature of the concrete that afforded them, as to appear to be yet ſomewhat compounded, and oftentimes to differ in one concrete from principles of the ſame denomination in another:

NEXT,

NEXT, that as to the number of theſe differing ſubſtances, neither is it preciſely three, becauſe in moſt vegetable and animal bodies earth and phlegm are alſo to be found among their ingredients; nor is there any one determinate number, into which the fire (as it is wont to be employed) does preciſely and univerſally reſolve all compound bodies whatſoever, as well minerals as others, that are reputed perfectly mixt:

LASTLY, that there are divers qualities, which cannot well be referred to any of theſe ſubſtances, as if they primarily reſided in it and belonged to it; and ſome other qualities, which, though they ſeem to have their chief and moſt ordinary reſidence in ſome one of theſe principles or elements of mixt bodies, are not yet ſo deducible from it, but that alſo ſome more general principles muſt be taken in, to explicate them:

IF, I ſay, the chymiſts (continues *Eleutherius*) be ſo liberal as to make you theſe three conceſſions, I hope you will, on your part, be ſo civil and equitable, as to grant them theſe three other propoſitions, namely;

FIRST, that divers mineral bodies, and therefore probably all the reſt, may be reſolved into a ſaline, a ſulphureous, and a mercurial part; and that almoſt all vegetable and animal concretes may, if not by the fire alone, yet by a ſkilful artiſt employing the fire as his chief inſtrument, be divided into five differing ſubſtances, ſalt, ſpirit, oil, phlegm and earth; of which the three former, by reaſon of their being ſo much more operative than the two latter, deſerve to be looked upon as the three active principles, and by way of eminence to be called the three principles of mixt bodies.

NEXT, that theſe principles, though they be not perfectly devoid of all mixture, yet may without inconvenience be ſtyled the elements of compounded bodies, and bear the names of thoſe ſubſtances, which they moſt reſemble, and which are manifeſtly predominant in them; and that eſpecially for this reaſon, that none of theſe elements is diviſible by the fire into four or five differing ſubſtances, like the concrete, whence it was ſeparated.

LASTLY, that divers of the qualities of a mixt body, and eſpecially the medical virtues, do for the moſt part lodge in ſome one or other of its principles, and may therefore uſefully be ſought for in that principle ſever'd from the others.

AND in this alſo (purſues *Eleutherius*) methinks both you and the chymiſts may eaſily agree, that the ſureſt way is to learn by particular experiments, what differing parts particular bodies do conſiſt of, and by what ways (either actual or potential fire) they may beſt and moſt conveniently be ſeparated, as without relying too much upon the fire alone, for the reſolving of bodies, ſo without fruitleſsly contending to force them into more elements than nature made them up of, or ſtrip the ſever'd principles ſo naked, as by making them exquiſitely elementary, to make them almoſt uſeleſs.

THESE things (ſubjoins *Eleutherius*) I propoſe, without deſpairing to ſee them granted by you; not only becauſe I know, that you ſo much prefer the reputation of candour before that of ſubtilty, that your having once ſuppoſed a truth would not hinder you from imbracing it, when clearly made out to you; but becauſe, upon the preſent occaſion, it will be no diſparagement to you to recede from ſome of your paradoxes, ſince the nature and occaſion of your paſt diſcourſe did not oblige you to declare your own opinions, but only to perſonate an antagoniſt of the chymiſts. So that (concludes he, with a ſmile) you may now, by granting what I propoſe, add the reputation of loving the truth ſincerely to that of having been able to oppoſe it ſubtilely.

CARNEADES's haſte forbidding him to anſwer this crafty piece of flattery; Till I ſhall (ſays he) have an opportunity to acquaint you with my own opinions about the controverſies I have been diſcourſing of, you will not, I hope, expect I ſhould declare my own ſenſe of the argument I have employed. Wherefore I ſhall only tell you thus much at preſent; that though not only an acute naturaliſt, but even I my ſelf could take plauſible exceptions at ſome of them; yet divers of them too are ſuch as will not perhaps be readily anſwered, and will reduce my adverſaries, at leaſt, to alter and reform their hypotheſis. I perceive I need not mind you, that the objections I made againſt the quaternary of elements and ternary of principles, needed not to be oppoſed ſo much againſt the doctrines themſelves; either of which, eſpecially the latter, may be much more probably maintained than hitherto it ſeems to have been, by thoſe writers for it (I have met with) as againſt the unaccurateneſs and the unconcludingneſs of the analytical experiments vulgarly relied on to demonſtrate them.

AND therefore, if either of the two examined opinions, or any other theory of elements, ſhall, upon rational and experimental grounds, be clearly made out to me; it is obliging, but not irrational, in you to expect, that I ſhall not be ſo far in love with my diſquieting doubts, as not to be content to change them for undoubted truths. And (concludes *Carneades* ſmiling) it were no great diſparagement for a ſceptick to confeſs to you, that as unſatisfied as the paſt diſcourſe may have made you think me with the doctrines of the Peripateticks, and the chymiſts, about the elements and principles, I can yet ſo little diſcover what to acquieſce in, that perchance the enquiries of others have ſcarce been more unſatisfactory to me, than my own have been to my ſelf.

EXPERIMENTS AND NOTES ABOUT THE Produciblenefs of Chymical Principles;

Being Parts of an Appendix, deſigned to be added to the SCEPTICAL CHYMIST.

The Author's Preface.

HAVING long ſince obſerved, that a great part of the erroneous reaſonings and concluſions of learned men, as well about phyſical, as other ſubjects, proceeds not ſo much from their making bad illations, as from their aſſuming falſe or uncertain principles, to draw their conſequences from; I thought, I could ſcarce miſ-ſpend the time I allowed my ſelf for chymical ſtudies, if I employed ſome part of it, in examining the doctrine about the principles of natural bodies. Upon this account I did, in the year 1661, venture abroad my *Sceptical Chymiſt*, to acquaint the inquiſitive with my doubts, and excite them to a more thorough diſquiſition of a ſubject, ſo conſiderable, as well to natural philoſophy, as to phyſick. This diſcourſe being once publiſhed in Engliſh, and ſoon after in Latin; I thought fit to wait a while, that I might learn what judgment would be made of it, and whether any of the chymiſts would return an anſwer to it: and in the mean while, to gratify thoſe, that appeared deſirous of having it ſoon reprinted, I gathered divers notes, (ſome of them conſiderable for bulk) to be inſerted here and there, as inlargements in the next edition, whoſe volume I was not unwilling ſomewhat to increaſe, not only becauſe I thought truth in general, a thing worthy, that the lovers of it ſhould take pains to diſcover, and eſtabliſh it, but becauſe I looked upon the truth inquired after in the *Sceptical Chymiſt*, as of no mean importance; eſpecially ſince the miſtakes, that very many have made about it, have, I fear, not only been prejudicial to natural philoſophy, but have, by ſeveral men, as well learned as ignorant, been adopted both into the ſpeculations, and practice of phyſicians; whoſe art being converſant about the health and life of man, doctrinal errors in it cannot but be dangerous, and therefore fit, as much as is poſſible, to be ſolicitouſly avoided, or removed. Theſe inconveniencies I hoped might in ſome meaſure be obviated, if it were further made appear by experiments as well as reaſonings, that the vulgar doctrine of the *tria prima* is, at leaſt, very queſtionable, or uncertain and very narrow. For the contrary perſuaſions about theſe principles have miſ-led divers learned men to give, and take up with precarious and ſuperficial accounts of divers phænomena of nature; by which means they have been diverted from employing their wits (wherein divers of them are happy) in the inveſtigation of the true and fundamental cauſes, the diſcovery whereof would have enabled them, inſtead of dark and ſuperficial, to give intelligible and particular explications of thoſe phænomena, and many others. The difference between the accounts given of the ſame phænomena, by the hypoſtatical and by the mechanical principles, may be ſeen exemplified by particular inſtances in other papers; wherefore, I ſhall proceed to obſerve as to phyſick, that beſides the miſtakes, which, I doubt, divers learned men have, by another valuation of the doctrine of the *tria prima*, been led into, in relation to the cauſes of divers things, that occur to human bodies, and even in chymical operations; beſides this, I ſay, I fear, that the too confident opinion of the doctrine I queſtion has made divers practitioners of phyſick make wrong eſtimates of medicines. But after I had waited a competent time, I perceived no author vouchſafed the *Sceptical Chymiſt* an anſwer; but a very ingenious man, from whom I chiefly expected it, told me, that he had indeed deſigned to write one, but was hindered by conſidering, that I had ſo ſtated the caſe, that an anſwer could not confute that book by any mere juſtification of the chymiſts principles, ſince he would be obliged alſo to defend the chymical doctrine, as it is generally taught by the vulgar chymiſts; and make good the arguments, by which they are wont to maintain it. Since it is only that doctrine and theſe arguments, that I declare my ſelf in that diſcourſe to queſtion; and he himſelf did not think them ſound and valid. By theſe encouragements I was induced to comply with

with the earneſt ſolicitations of the printer for another edition; but he dying ſoon after, and the perſon, to whom the right to diſpoſe of the Engliſh copy legally came, having left *England*, and continued out of it, for divers years, the diſpute between the Stationers that pretended to it, and treated about it, laſted ſo long, that a traveller, who paſſed this way, told an acquaintance of mine, that he had then (which was two or three years ago) ſeen nine ſeveral Latin impreſſions of it; ſince when another has been brought me made at *Geneva*. This number of editions (in none of which I have added or altered a word) and the numerous citations I have met with of it, in favourable writers, made me unwilling to confound, or trouble readers, by interweaving additional notes with the body of the diſcourſe; and ſo by obliging thoſe that ſhould hereafter vouchſafe to mention any of the inſerted paſſages of it, to cite the edition as well as the book. And therefore I was eaſily inclined, by want of health and leiſure, to peruſe again deliberately the whole treatiſe, to ſuppreſs all thoſe notes, that I could not readily and conveniently refer to three or four of the chief heads, I intended to enlarge upon; and without altering the form of the book, wherein it has proved ſo fortunate, to leave it intire, and publiſh my additions alſo by themſelves by way of appendix. This in my intention was to conſiſt of four heads, The *Producibleneſs of chymical Principles*; The *Uncertainty of the vulgar Analyſes made by diſtillation*; The *various Effects of the Fire according to the differing ways of employing it*; and *Doubts whether there be any Elements, or material Principles of mixt bodies, one or more, in the ſenſe vulgarly received.* But finding by the Stationer's eſtimate, that the notes referred to the three laſt titles, are not near ſo large as thoſe, that belong to the firſt; yet they would make the book, to which they ſhould be added, and which is already printed, of too great a thickneſs in proportion to its other dimenſions; I thought fit to reſerve the other papers for another opportunity, and at this time annex nothing, but what concerns *the Producibleneſs of the chymical Principles.*

BUT yet becauſe there are ſome general advertiſements that do ſomewhat more belong to this part of our deſigned Appendix, that now comes forth, than to any of the reſt, I muſt not deny them a room in this preface, which I ſhall conclude with them.

I MIGHT juſtly enough alledge, in excuſe of incoherence of ſome of the particulars, that follow next after one another in the ſubſequent diſcourſe, that this being confuſedly but a collection (or if you pleaſe a rhapſody) of looſe notes, it is more pardonable, than ſtrange, that ſome of them ſhould want apt connections, and the ſtyle of the diſcourſe they compoſe ſhould want uniformity. But it is not ſo much my preſent work to make apologies, as to give advertiſements; and therefore I ſhall proceed to tell you in the firſt place, that though the following diſcourſe have in ſome places a ſomewhat dogmatical dreſs, yet it is chiefly meant (as becomes an appendix to a ſceptical book) to excite and aſſiſt a further inquiry; and accordingly the reader may perceive it to have been my care, not ſo much to play the part of a logical opponent, as to take occaſion to ſet down variety of experiments and obſervations, that whatever hypotheſis about the material principles of mixed bodies ſhall prove fit to be pitched upon, it may be founded on a leſs inſufficient hiſtory of matters of fact (relating to that ſubject) than chymiſts have been wont to take in; and may be ſo framed, as not to be liable to thoſe objections and difficulties, that will be here met with, and yet perhaps were not thought of, or at leaſt were not duly taken into conſideration, when the vulgar hypotheſis of the *tria prima* was eſtabliſhed. Upon this account I am not without hope, that the following experiments and conſiderations, though propoſed by way of objections, may do ſome ſervice to the inquirers into the material principles of things; by obliging the chymiſts, at leaſt, to reform their doctrine about them, and build it more cautiouſly, and that upon a larger, as well as more ſolid foundation of natural hiſtory.

THE ſecond thing, whereof I am to advertiſe the reader, is, that I would not have him infer from any thing, that (prompted by the exigencies of my deſign) I have ſaid in the following papers, that I either do undervalue, or would decry chymiſtry, or chymiſts themſelves indiſcriminately. For I have a very differing eſteem of the notional and of the practical part of chymiſtry. For divers of the opinions maintained by Spagyriſts, without excepting their grand hypotheſis of the three principles, I have been inclined to queſtion, not only as a naturaliſt, but as a chymiſt; as ſeeing great cauſe to doubt, whether they be agreeable, either to the true grounds of philoſophy, or the exploring experiments of the fire. But as for chymical operations, ſuch as diſtillation, ſolution, ſublimation, precipitation, and the reſt; eſpecially thoſe ſeldom ſufficiently valued ones, digeſtion and cohobation; I take them to be excellent tools in the hands of a natural philoſopher, and to be by him applicable to many other, and perhaps ſome nobler uſes, than they are wont to be put to, in laboratories; ſince if they be ſkilfully employed, they may be ſucceſsfully ſo, as well to diſcover nature, as to correct, to imitate, and, in ſome caſes, to out-do her. Nor do I only thus diſtinguiſh between the ſpeculative and operative part of chymiſtry, but I make a great difference between the avowed cultivators of that art; and look not with the ſame eyes on the opinions and performances of vulgar chymiſts, and chymical philoſophers. For we are told, that there lives concealed in the world a ſett of Spagyriſts of a much higher order than thoſe, that are wont to write courſes of chymiſtry or other books of that nature; being able to tranſmute baſer metals into perfect ones, and do ſome other things, that the generality of chymiſts confeſs to be extremely difficult, and divers of the more judicious, even among the Spagyriſts themſelves, have judged impoſſible. The declaration of what I think of theſe latent philo-

ſophers, belongs to another paper. Yet in this, I ſhall not deny, but that what I have heard from divers very credible eye-witneſſes, and perhaps ſome more immediate arguments, ſtrongly incline me to think, that there may have been, and may yet be, ſome ſuch men: and whatever be to be thought of what they call the philoſopher's ſtone, I confeſs my ſelf convinced by what I have ſeen, that there are in the world as difficult arcana as divers of thoſe, which have been (perhaps not all of them juſtly) derided under the name of chymical *non-entia*. Now if there be really ſuch adept philoſophers as we are told of; I am apt to think, that among their other arcana, they are maſters of extremely potent menſtruums (which may, as far as I can gueſs, be ſome of their chiefeſt tools) and may by the help of theſe and other means peculiar to themſelves, of working upon bodies, be able to produce in them ſuch alterations, as we have no examples of, and ſo obtain from them ſuch ſimilar ſubſtances, as either for number, or quality, or both, may be very different from the vulgar *tria prima*, or thoſe ſubſtances chymiſts are wont to obtain, (for that word I chuſe to employ rather than the word ſeparate or extract) by the common ways of what they call analyſis. For if a man have an inſtrument, which other men have not, and much more, if it be an excellent one, he may be able with it to perform other things, than they can without it. The Europeans by the help of ſo ſlight an engine as a mill, aſſiſted by a far ſlighter inſtrument a ſieve, can eaſily divide corn into bran, and meal, and flour, which even thoſe Americans, for want of thoſe helps, were not able to do, who could do other things, that are thought far more difficult. And he, that has a file and a good turning lath with its appurtenances, may obtain from a piece of iron both filings, and ſhavings, and concave hemiſpheres, and ellipſes, and globes, and cylinders, and other ſorts of bodies, which could not be obtained from that iron, even by good artificers, that were not furniſhed (as till of late very few were) with thoſe inſtruments. And he, that firſt found the uſe of aqua fortis in diſſolving ſilver, and that though it were mixt with gold, had, by his menſtruum, an eaſy way of ſeparating thoſe two metals, though ancienter mineraliſts, nor chymiſts themſelves had no liquor that would perform that work. But *Helmont*'s writings will ſupply me with a far nobler inſtance to my preſent purpoſe, if the truth of all that he delivers concerning the effects of his alkaheſt be admitted; about the poſſibility of which ſtrange ſolvent, having elſewhere written a ſhort enquiry, I ſhall forbear to ſay any thing of it here, but rather intimate, that if there be ſuch adept philoſophers as ſome ſpeak of, (which I think not incredible) and if they have (which, ſuppoſing there be ſuch, I think not unlikely) among other rare things, ſome alkaheſtical or other extraordinarily potent menſtruum, or way of penetrating and working upon mixt bodies; they may, for aught I know, be able to obtain ſuch ſubſtances from them, as may induce me, and perhaps the chymiſts too, to entertain other thoughts about the conſtitution of compounded bodies (as they are wont to be called) than either I, or they now have. And therefore, though as to natural philoſophy in general, I do not expect to ſee any principles propoſed more comprehenſive and intelligible than the corpuſcularian or mechanical; yet as to the ſubordinate theory of mixt bodies in particular, I, that have diſputed only againſt the vulgar hypotheſis of the chymiſts, can eaſily retain a diſpoſition to receive further light in this matter, when thoſe, that are the beſt able to afford it us, and from whom it will be no diſparagement for much greater proficients than I, to learn, ſhall think fit to oblige us by doing ſo. In the mean time, to end this advertiſement as I begun it; I ſhould not need to ſay much to ſatisfy chymiſts, that I neither hate nor deſpiſe their art, even in its preſent ſtate, if ſome things, and chiefly want of leiſure, would permit me to publiſh an eſſay that I wrote many years ſince, *Of the Uſefulneſs of Chymiſtry to the Empire of Man.* Nor is it only to the practical part of natural philoſophy, that I take chymiſtry, as it may be managed, to be highly uſeful, but I confeſs, I think alſo, that being ordered by a ſkilful naturaliſt, it may far more conduce, than thoſe, that are ſtrangers to it are wont to think, to the ſpeculative part of phyſicks; and that as the Bolonian ſtone, without being chymically prepared, would never be made luminous, but being ſo prepared is brought to ſhine; ſo, many other natural bodies never afford much light to philoſophy, till chymical operations have qualified them to do ſo.

THE laſt advertiſement I deſire to give the reader, concerns the intention, with which I call in queſtion the hypotheſis of the *tria prima*, and ſome other of the chymiſts doctrines. For though ſometimes I have had occaſion to diſcourſe like a Sceptick, yet I am far from being one of that ſect; which I take to have been little leſs prejudicial to natural philoſophy than to divinity itſelf. I do not with the true Scepticks propoſe doubts to perſuade men, that all things are doubtful and will ever remain ſo, (at leaſt) to human underſtandings; but I propoſe doubts not only with deſign, but with hope, of being at length freed from them by the attainment of undoubted truth; which I ſeek, that I may find it; though if I miſs of it in one opinion, I proceed to ſearch after it in the oppoſite, or in any other where it ſeems more likely I ſhould meet with it. And to declare my mind to the diſciples of the fire, by a ſimilitude not aliene from their profeſſion; ſuppoſe a man, more rich than ſkilful, ſhould bequeath me a purſe of guineas, and that I ſhould have ſtrong preſumptions, that ſome of them are counterfeit, what in this caſe would a chymiſt have me do? To take them all for good, in ſpite of contrary preſumptions againſt ſome of them, were very imprudent. On the other ſide, to throw them all away, becauſe it is probable ſome may prove counterfeit, were downright folly. That then, which common prudence would direct me, would be to take them all out, and examine them one by one, firſt with the touch-

touch-ſtone, and then, if need be, by the cupel, and by aqua fortis too: and this I ſhould do with deſire to find all the pieces true, having alſo care not only to preſerve and put back into the purſe thoſe, that prove right; but if any be but partly adulterated, to preſerve the good portion by purifying it, (by the cupel or ſome other fit way) from the falſifying alloy, by whoſe admixture it had been imbaſed. The application of this I leave to be made by chymiſts. And having, in another paper, purpoſely diſcourſed of the cautions and limitations, without which I diſallow ſcepticiſm, I ſhall only in general profeſs, that I more willingly embrace the truths taught by the chymiſts, than I endeavour to diſprove their errors. For I look upon truth, as one of the chief of thoſe goods, that God has of all others laid the moſt in common; ſince truth does not only, like deſert iſlands in *America*, belong to him, that firſt finds it and ſeizes on it; but even, when another has lighted on it, and is in poſſeſſion of it, any man may, without treſpaſs or injury, make himſelf a ſharer in it. To conclude; I am glad to find truth in the doctrines of the chymiſts; but when I cannot diſcern it there, I chuſe rather to ſeek it elſewhere, than ſit down without it. And if I any where ſeem to be ſomewhat too indulgent to ſuſpicions againſt their hypotheſis, or arguments, I hope the uſual confidence, to be met with among moſt of them, conſidered, it will be looked upon but as a compliance with the advice of *Ariſtotle*, of bending a crooked ſtick the contrary way, to reduce it at length to ſtraitneſs. And I did, with the leſs ſcruple, allow my ſelf this way of writing, becauſe experience having taught me, that ſome Spagyriſts (for I ſpeak not of all) that keep their beſt things cloſe, will do more to vindicate their art, or oppoſe their antagoniſts, than to gratify the curious, or benefit mankind; I thought the rouſing ſtyle, I ſometimes wrote in, might prove no unhopeful way to procure ſomewhat conſiderable from thoſe great maſters, and orders of chymical arcana, that muſt be provoked, before they will come out with them; as the ſea is obſerved not to give us one of its precioueſt treaſures, ambergreaſe, till it have been agitated by winds and ſtorms.

The Publiſher's Advertiſement to the Reader.

I SHALL not entertain the reader with any thoughts of my own, about the following Appendix, which, without deſiring to prepoſſeſs him, I ſhall willingly (and I think may ſafely) leave to ſpeak for itſelf. But yet I think it may not be amiſs, if I premiſe ſomething to the reader, about the publication of theſe notes, as having been particularly concerned in it

By the opportunity I had of ſeeing ſome papers of the honourable author of the enſuing Appendix; I perceived, that the notes, which he deſigned it ſhould conſiſt of, were indeed moſt of them laid together in ſome (though but a careleſs) order, and ſo were without much difficulty fitted for the preſs: but others of them lay ſcattered up and down amongſt many others, about differing ſubjects in his philoſophical memorials, which particulars not being ready at hand, when the enſuing Notes were ſent to *Oxford* to the printer, they could not be publiſhed with the reſt, but muſt expect ſome other opportunity to appear abroad, either alone, or in their company.

Perhaps the reader will not need to be told, that beſides the application of ſome of the experiments contained in the following Notes, moſt of the experiments themſelves are new. But ſo many years are paſt betwixt the firſt edition of the *Sceptical Chymiſt*, and the ſecond, that now comes forth; that it may be requiſite (though otherwiſe it would be improper) to advertiſe this reader, that he is not to think, that the author has borrowed from others thoſe experiments and notions, that may be met with in books written in later years, as well as in the *Sceptical Chymiſt*. For the firſt Engliſh edition having been put forth in the year 1661, and never ſince by the author at all enlarged, or altered; it will ſufficiently ſhew, that this book could not borrow from thoſe, that never were ſeen till after, and perhaps long after his was publiſhed. Which advertiſment may be particularly applied to the late learned treatiſe, intitled *Philoſophia Vetus & Nova*, wherein in one long chapter may be met with an abridgment of a great part of the notions, experiments, and ratiocinations of the *Sceptical Chymiſt*, without any mention there made, either of the great and famous author's name, or his book, in which they firſt appear; though the Latin verſion of that treatiſe was publiſhed many years ago, and reprinted many times ſince. And though this be not the only writer, that hath thought fit to make uſe of conſiderable portions of the *Sceptical Chymiſt*, without owning it, I thought, what he has been pleaſed to do, required to have particular notice taken of it, becauſe, though his modeſty hath perſuaded him to conceal his name, his learned book hath made him ſo juſtly famous, that if the reader were not advertiſed, he might eaſily ſuſpect, that Mr. *Boyle* had not lent to, but borrowed of an author, who appears ſo capable of enriching the curious with excellent things of his own. And upon the ſame grounds I think it neceſſary to obſerve, that the experiments to be met with in Mr. *Boyle's Hiſtory of Colours* having been publiſhed many years ago, could not be borrowed from that moſt ingenious treatiſe, though in that chapter of it, which treats *de coloribus*, between 20 and 30 experiments, (if I meſremember not the number) will be found the ſame with the like number of Mr. *Boyle's*; whoſe

whoſe name, though elſewhere very civilly taken notice of on ſome other occaſion, is in that whole chapter left unmentioned.

I MIGHT here inform the reader, that the *Sceptical Chymiſt* having been many years out of print, it chanced, that when the notes, that make up the following Appendix, were drawn together for the preſs, this author had not a book at hand, by comparing whereof with the particulars of his deſigned Appendix, he might be ſure to avoid, (what he now but hopes he hath,) the ſuffering any thing to paſs in the latter, that is truly coincident with what was already extant in the former: (I mean, to the ſame purpoſe, and on the ſame occaſion; for otherwiſe an experiment or notion may be more than once employed without meer repetition.)

AND laſtly I dare not omit to let the reader know, that ſince the Appendix was printed, it appears, that by an overſight, ſome leaves were left behind, that treating of the difference of common mercuries themſelves, ſhould have been annexed, as a kind of appendix to the laſt of the three mercurial tracts, to be met with among the following papers: from whoſe peruſal the reader ſhall no longer be detained by

His Humble Servant,
I. M.

The Introduction to the following NOTES.

THOUGH the pompous title of *Hypoſtatical Principles*, which chymiſts have beſtowed upon the ingredients they would have mixt bodies to conſiſt of, has perhaps ſerved to procure them a veneration from vulgar heads, that are wont to eſteem things the more becauſe they underſtand them leſs; yet the main thing, that has recommended the chymical principles to more diſcerning men, ſeems to be, that by the help of a few ſimple ingredients (whereof nature is ſuppoſed to have laid up great magazines at the beginning of things) aſſociated in differing proportions, all mixt bodies may be compounded; and ſo men may acquaint themſelves with the natures of a multitude of bodies, by firſt knowing the natures but of a few. He therefore, that acknowledges he does not acquieſce in the chymical hypotheſis of the *tria prima*, or their's, that add to them water and earth, can ſcarce imploy a more proper argument to ſhake it, than, upon good ground, to call in queſtion what they teach when they affirm, that their principles are ingenerable and incorruptible; and that nature does only compound and diſſociate them, without either producing or deſtroying any of them. It will be therefore very well worth while to examine, what evidence there is in an aſſertion, which, in ſo many of the chymiſts reaſonings and explications, is either manifeſtly imployed, or not obſcurely ſuppoſed. And indeed this tenet of theirs is ſo principal a pillar of their hypotheſis, that, in caſe it fail them, the whole ſtructure will be in danger of ruin. For if the bodies they call principles be produced *de novo*, how will it be demonſtrable, that nature was obliged to take thoſe principles made ready to her hand, when ſhe was to compound a mixt body? and how will it appear in every analyſis made by fire, that the ſalt (for inſtance) thereby obtained, was not produced by the chymical operations, but was pre-exiſtent in the body in minute parts, which, by the action of the fire, were only extricated and ſeparated from the other principles or ingredients, and afterwards brought together? Since, in caſe the chymical ſuppoſition be erroneous, not only the obtained ſalt may be in part due to a new production or tranſmutation, but part of that, which was really ſalt, if any ſuch thing there were antecedently to the analyſis, might be either deſtroyed by the operation, or made to appear under ſome other form.

OF THE

Produciblenes of Chymical Principles.

PART I.

Of the Produciblenes of ſalt.

AMONG the ſubſtances, upon which chymiſts have conferred the title of principles, ſalt ſeems in their eſtimate to have had the precedency, ſince they are wont to name it firſt in the enumeration of their *tria prima*. And it is generally granted, that ſalts are wont to be the moſt conſiderable and active parts obtained by chymiſts from mixt bodies. And yet perhaps the inviſible particles, that compoſe the viſible portions of a ſalt, may be ſuch, and ſo contrived, as to be fit to make, and to have perhaps actually made, other portions of matter endowed with thoſe qualities, for which chymiſts are wont to call

a body ſulphureous or mercurial, as may be inſtanced in the inflammability of nitre. Wherefore it may deſerve a greater meaſure of curioſity, than ſeems to have been employed, or even deſigned, by vulgar chymiſts, to enquire, whether ſalt, indefinitely ſpeaking, may be produced *de novo*, (as they phraſe it) or deſtroyed; and whether at leaſt the particular, and much differing ſpecies of ſalts may be changed into one another, and thereby, after a manner, be produced in reference to the acquired ſpecies of ſalt, and deſtroyed in relation to that, which the ſame portion of matter belonged to before.

To premiſe ſomewhat in general, to render it probable, that ſalts may be produced *de novo*, I ſhall briefly repreſent two things; the firſt is, that ſince ſalts differ much in ſeveral other attributes, ſome being fixt, ſome volatile, ſome acid, ſome urinous, *&c.* the two qualities, wherein they agree, and which therefore make up the common and moſt received notion of ſalt in general, are, that it is eaſily diſſoluble in water, and that it affects the palate with a ſapor, whether good or evil: and the other thing is, that, whether we allow the Epicurean hypotheſis, or the Carteſian, the firſt ſaline concretions, that were produced by nature, muſt be confeſſed to have been made of atoms, or of particles, that before their conjunction, were not ſaline. And therefore there appears no abſurdity in conceiving, that by the action of the fire or other fit agents, ſmall portions of matter may be ſo broken into minute parts, and theſe fragments may be ſo ſhaped and connected, as, when they are duely aſſociated, to compoſe a body capable of being diſſolved in water, and of affecting the organs of taſte

THAT a diſpoſition to be diſſoluble in this or that liquor may be acquired by mixture, and the new texture of parts, is not without example; for, as I elſewere obſerve, though powdered ſulphur will lie in well rectified ſpirit of wine, ſome weeks or months, without being at all viſibly diſſolved in it; and though the ſame liquor will for as long a time ſwim upon ſalt of tartar, without making a ſolution of it; yet if this ſalt and ſulphur be mixt together, ſpirit of wine will in leſs than an hour, and ſometimes in leſs than a quarter of that time, diſſolve enough of this matter to be richly colourd by it, and this without the help of external heat. And I ſee not, why it ſhould be impoſſible, that the action of the fire may reduce the corpuſcles of bodies to ſuch a minuteneſs, and aſſociate them either among themſelves, or with the corpuſcles of other bodies, which, without preparation, will not diſſolve in water, that the pores intercepted between them may be entered, and their looſe texture diſſolved by that menſtruum. Of which conjecture though we have not a perfect inſtance, yet we have a probable one in that, which I ſhall hereafter deliver concerning the making of fixt nitre. For though the cryſtals of well purified ſalt-petre may be kept many weeks or months in an ordinary lodging-chamber (for I had not occaſion to try it in a cellar) without relenting by the moiſture of the air; yet if without the addition of any body diſſoluble in water, or moiſt air, it be in great part reduced, as perhaps it may be almoſt in a trice, to a fixt alkali, this ſalt will be eaſily enough penetrable by the vapours, that rove up and down in the air; and will by that moiſture, in no long time, be brought to relent, and at length will be reſolved into a liquor very analogous to that, which the chymiſts make of ſalt of tartar left in moiſt cellars to deliquate.

As for the ſapor, which is the ſecond qualification to be conſidered in the vulgar notion of a ſaline body, I doubt, whether the neceſſity of it be agreeable to another principle of theirs, and to experience. For it is plain, that chymicall oils, even thoſe pure ones they call *eſſential*, or even ethereal ones, are highly ſapid: and yet theſe not diſſolving in water, it ſeems there is no ſtrict connection betwixt being ſaporous, and being ſoluble in that liquor; and that, if bodies be reduced into a multitude of parts minute and ſharp enough, it is very poſſible, that ſome of theſe, either in part, or in conjunction with others, may acquire a ſize and ſhape, that fits them ſenſibly to affect the organ of taſte, though perhaps the bodies themſelves, or perhaps thoſe bodies, that afforded them, are more of ſome other nature than of a ſaline. This may be illuſtrated by theſe groſs examples; that a ball of glaſs, for inſtance though, whilſt it is entire, it will not prick and hurt the ſkin, yet if it be broken and beaten, the little fragments will, not as they are glaſs, but as they have points or edges. And ſo, though a ſtick, being graſped in a man's hand, will not pierce the ſkin, or put him to pain; yet if it be cut into tooth-picks or reduced to ſplinters, their ſharpneſs and ſtiffneſs gives them a power to wound, that they had not before. Something analogous to what we, in theſe examples, ſee to be done upon the organs of touch, may be conceived to be done upon the organs of taſte (which is a kind of touch) of which an almoſt full inſtance may be given in purified ſalt-petre. For though this concrete have but a faint and languid taſte, yet if it be carefully diſtilled with ſome additament, that is not diſſoluble in water, and is inſipid, the parts of it being, by the action of the fire, either broken aſunder, or cleft, or rubbed, or ground againſt one another, till they are reduced to edged and pointed corpuſcles; ſalt-petre, I ſay, thus treated will be reſolved into differing ſubſtances, each of which has an extremely ſtrong and penetrant taſte, which, whence it ſhould proceed but from ſome ſuch mechanical change, as we have been deſcribing, is not eaſy to declare: and perhaps alſo the phlegmatick liquor, that is wont to come over in this analyſis, may, at leaſt as to part of it, be produced by the operation of the fire, and ſo the phlegm being inſipid, the taſte, I mean as much as was in the unanalyzed nitre, may be as well deſtroyed, as thoſe of the ſpirit and alkali are generated by the operation of the fire. But perhaps there needs no other argument, that the ſame parts of matter, according to its differing ſtates, may have the

qualities, that chymiſts would have to be proper to this or that principle, than what we have took notice of in chymical oils, which do more ſtrongly affect the taſte, than the moſt of ſalts themſelves are found to do. And to confirm our doctrine of the producibleneſs of ſalts by the authority of *Helmont*, which is very great, at leaſt with the chymiſts of his own ſect, I ſhall obſerve, that he aſſures us, that by *Paracelſus*'s *ſal circulatum* ſolid bodies, among which he particularly, and in the firſt place, inſtances ſtones, may be tranſmuted into actual ſalt equiponderant to the body whereof it was made. So that upon the chymiſts ſuppoſition, that in theſe mixt bodies there is both ſulphur and mercury, beſides a *terra damnata*, the ſame portions of matter, that pre-exiſted in the form of either of thoſe ſimple ingredients, muſt, by the operation of the fire, and an anomalous menſtruum, have been turned into ſalt; and if the Helmontian experiment be allowed of, whatever becomes of the chymical ſuppoſition, we may ſafely conclude, that ſalt may be made of matter, that was not ſalt before, and conſequently that ſalt may be *de novo* produced. And thus much of the poſſible origination of ſalts in general, which I thought fit to premiſe to what I am going to offer about the production of the particular ſorts of ſalt. Though I have elſewhere enumerated and diſtinguiſhed ſeveral kinds of theſe bodies, whereto chymiſts have given the title of ſalts; yet thoſe, that more properly deſerve that name, and more directly appertain to our preſent diſquiſition, ſeem to be chiefly theſe three: the acid, ſuch as vinegar, ſpirit of ſalt, *&c.* the alcalizate or fixed lixiviate ſalts, made by burning, ſuch as ſalt of tartar, and of wormword, barillia, pot-aſhes, *&c.* and the volatile and urinous ſalts, ſuch as ſalt of hartſhorn, of urine, of blood, of ſoot, *&c.* which taſte and ſmell like that of urine. Wherefore, if we can ſhew, that theſe may be produced *de novo*, or (which we have intimated to be equivalent for our purpoſe) tranſmuted into one another, we ſhall, I hope, be thought to have ſucceeded in our preſent attempt.

Vide Helmontium in tractatu dicto Elementa, N° 11. *& alibi.*

SECT. I.

Of the production of acid ſalts.

AND to begin with acid ſalts, we ſee, that even ſweet wines will but too often, without addition, degenerate into ſour vinegar, which will diſſolve coral and divers ſtones, calcined lead, and ſeveral other minerals. The rain-water, that is imbibed by the roots of trees, is in thoſe, that bear limons and barberries changed into liquors, abounding with ſaline corpuſcles, that enable them to affect the taſte, and act on powdered pearls, and ſeveral other bodies, as acids are wont to do. Alſo guaiacum and divers other woods, that do not at all taſte ſour, will, being diſtilled in retorts, afford ſpirits, that are furniſhed with ſtore of acid particles, which, as I have tried, will hiſs upon alcalies, and will diſſolve coral, and even lead itſelf calcined into minium, and make *ſaccharum Saturni* of it. Many other vegetable bodies alſo do, without addition, afford the like acetous liquors. And if it be objected, that theſe were pre-exiſtent in the bodies, whence they were obtained, and were only extricated by the operation of the fire; it will concern thoſe, that affirm this, to prove it, (which no body, that I have met with, hath yet done:) and I ſhall the rather require it, becauſe I find, that the ſweeteſt bodies, and thoſe of differing kinds, as (to omit raiſins of the ſun) ſugar and honey themſelves, afford ſuch a ſort of ſpirits, which the trials, I elſewhere mention, ſhew to be ſharp and piercing enough. To which may be added, that in divers caſes, where we are ſure, that acid ſpirits were plentiful ingredients of a compoſition, as in *ſaccharum Saturni*, and that magiſtery, which the chymiſts call ſalt of coral, (which are not the only mixtures I have made trial of,) experience witneſſeth, that the liquor, which comes over by diſtillation in retorts, is not acid, but quite of another kind. I would not, by what has been ſaid, be concluded to deny, that acid ſalts may, in ſome mixt bodies, be ſo aſſociated with others, and obſcured by them, as not to be diſcernible by the taſte, till they be ſeparated by the operation of the fire. But to ſhew, that ſuch acid ſalts were *de facto* pre-exiſtent, as acid ones in the body, that affords them, there muſt be ſome poſitive proof, other than the liquors diſtilled from them, ſince they, as we have already argued, may be not barely extricated, but may have their acidity produced by the operation of the fire. And we ſee, that ſalt-petre, though it have no acid taſte, may be made to afford, by (a certain way of) diſtillation, above three quarters of its weight of a highly acid liquor; and yet it appears not, that ſuch a great proportion of acid particles, or poſſibly any conſiderable proportion at all, was employed by nature in the compoſition of ſalt-petre. At leaſt, having diſtilled earth, that I cauſed in my own preſence to be dug out of a pigeon-houſe below the dung; I had from it a ſalt indeed, and ſome little ſaline liquor, but of a nature, as far as I obſerved, very differing from that of the acid ſpirit of nitre. (But this experiment I mention occaſionally, without building upon it.)

NOR do I think, it ought to ſeem incredible, that acid ſalts, as well as others, ſhould be producible by the various ſplittings, attritions, coalitions, and changes of texture, which may be cauſed ſeveral ways, and eſpecially by the operations of the fire; which moſt active agent, making a vehement and various agitation of all the minute parts, that a body conſiſts of, may, conſonantly to what hath above been intimated, ſplit or break ſome of them, and as it were grind others againſt one another; and in ſhort, ſo alter their bulk, figure and motions, as to make them fit to ſtab or cut the tongue, and the other bodies, that they work on, after the manner of thoſe bodies we call acid. But of this you may find more in our notes about the mechanical origin of taſtes; wherefore I now proceed to the ſecond part of my taſk.

SECT.

SECT. II.

Of the production of volatile ſalts.

AS to the production of volatile ſalts, we have an eminent inſtance of it in the ſalt obtainable by diſtillation from ſoot; for though the woods we burn in our chimneys ſeem not to have any thing of the taſte or ſmell of urinous ſalt, nor have the diſſolutions of the ſaline parts of ſuch woods communicated to water by their infuſion in it, been obſerved (that I know of) to be of affinity in taſte or odour with the ſalt of ſoot; yet when wood is firſt burnt in the fire, and then the ſoot afforded by it is duely diſtilled and rectified in fitly ſhaped veſſels, there is obtained a ſpirit and a white volatile ſalt, that in ſmell, taſte, and divers operations, by which we have examined them, appear to be of great affinity with thoſe of human blood, or urine, and may be eaſily enough miſtaken for them.

BUT this double operation of the fire is not always neceſſary to the production of volatile ſalts out of vegetables. For, though by their diſtillation in retorts we generally obtain from them no dry ſalt at all, but a ſouriſh ſpirit, with which I have diſſolved coral, lead, and other hard bodies, that urinous ſpirits have not been obſerved to work on; and they will, being put upon urinous ſalts, make ſuch an hiſſing and conflict, as are looked upon as great tokens of antipathy: yet I remember, that ſeveral years ago, I did from muſtard-ſeed, that had been kept for a convenient time, obtain by diſtillation a volatile ſalt, that faſtened itſelf in prettily figured grains to the upper part of the receiver, and this at the very firſt diſtillation; ſo that there was no need of rectifying the diſtilled matter, to ſeparate that ſalt. And to enforce this proof by ſomething more conſiderable than itſelf, I ſhall add, that by an eaſy way by word of mouth communicated to me by a very ingenious perſon (Dr. *D. E.*) one may, out of very many vegetables firſt duely prepared, without adding any thing to them, by bare diſtillations in retorts, obtain good ſtore of volatile ſpirits and ſalts, which by their fugacity, colour, ſmell, taſte, and divers experiments, that I purpoſely made to examine them, were ſo like the ſalt and ſpirit of urine, ſoot, *&c.* that one, that knew nothing of the way they were made by, would readily have concluded they belonged to one or other of the newly named ſorts of bodies.

I REMEMBER, that I have alſo ſometimes produced a volatile ſalt, that one would readily have pronounced urinous, of a mineral itſelf; nor was that the only foſſile, from which experience perſuaded me, that ſalt of this kind might be obtained.

SOME other particulars relating to the production of volatile ſalts, I think fit to reſerve, till I ſhall have occaſion to mention them in another ſection, (as inſtances of the production of urinous ſpirits.) Only there is one thing, that I think not fit here to pretermit, becauſe I have not met with it in any chymical writer, the contrary being rather generally taken for granted. I ſhall add then, that it is not univerſally true, that ſaline ſubſtances, that are volatile and aſcend in the form of ſalt, are of an urinous nature, and enemies to acids. For I have had from verdigreaſe, diſtilled *per ſe* with a ſtrong fire, a very acid ſpirit; which being warily rectified, afforded firſt a ſour phlegm, and then a penetrant ſpirit ſharper than it, leaving behind it in the veſſel ſome few ſpoonfuls of a dark-coloured liquor, which being ſet aſide, and ſuffered to reſt, did in a great part ſhoot into tranſparent cryſtals, large but thin, almoſt like thoſe of ſilver diſſolved in aqua fortis. They appeared prettily figured at the edges, but were ſo oddly connected among themſelves, that I was not able to refer them to any of the known geometrical figures; and their brittleneſs made them the leſs tractable, but their ſmell, which was ſtrangely piercing and not inoffenſive, argued them to be of the ſame nature with the acid ſpirit, which had come over with them.

BUT there is a more conſtant and eaſy way of producing ſuch a volatile ſalt, as my obſervation mentions. For if amber be gradually and warily diſtilled, it will afford, beſides the phlegm, ſpirit and oil, a dry ſubſtance, which, though the chymiſts call the volatile ſalt of amber, I found to be really of an acid nature, by ſeveral of thoſe trials, by which we are wont to diſcern, that a body belongs to the family of acids.

SECT. III.

Of the production of alkalies or lixiviate ſalts.

THE third and laſt ſort of ſalts, which we are to endeavour to ſhew to be producible, are the alkalies or fixt ſalts; which ſeem to have an antipathy with acid ones, by making a conflict with them, and exerciſing divers operations contrary to their's, (as I have in another diſcourſe more fully declared.)

As for the origin of theſe fixt ſalts of burnt bodies, the Spagyriſts are not of the ſame mind about it. For, the almoſt univerſal opinion of the chymiſts, that preceded *Helmont*, and the more common opinion even of later chymiſts, ſeem to have been, that theſe fixt alkalies are pre-exiſtent in mixt bodies; and that the fire does but ſeparate or extricate them from the other parts of the compounded body. But *Helmont* (followed in that by ſeveral chymiſts, that diſſent from him in other points) has ingeniouſly conjectured, that theſe lixivial ſalts do not pre-exiſt in their alcalizate form in the bodies, that afford them, but are productions of the fire, by whoſe violent action a part of the ſalt, which, in the concrete, is naturally all volatile, lays hold of ſome parts of the ſulphur of the ſame body, and both together are colliquated and fixt into an alkali; which fixation he ſomewhere exemplifies by that, which happens, when ſalt-petre and arſenick, that are both volatile, being expoſed to the fire, are by its operation fluxt and made to fix one another. But though this account be ingenious, yet I doubt, whether it be ſo clear and ſatisfactory, eſpecially ſince it is applied to all fixt alkalies, as the embracers of it think it. For beſides,

Vide Helmontium in Blas humano, N° 38, & 43.

that it may be queſtioned, whether it have yet been well proved (what *Helmont* teaches) that all the ſalt of mixt bodies before their combuſtion is volatile, it is not declared, what volatile ſalt is meant; though it be plain, that ſome bodies, that afford a fixt ſalt, do abound in acid ſpirits, as oak, box, and many other vegetables; and others, as hartſhorn, blood, urine, *&c.* abound with urinous ſalts, that exerciſe hoſtility with acids: and I have found, that from ſome bodies I could obtain both acid ſpirits, and ſuch as are wont to be called urinous. It is not eaſy to explain, how the volatile ſalt comes to unite it ſelf ſo intimately with the oil (or ſulphur;) and though it be alſo volatile it ſelf, to compoſe with it a body capable of enduring the violence of the fire, ſince we have more than once tried, that the volatile ſalt of urine, or of hartſhorn, and a chymical oil, as of turpentine or any ſuch, being put together, the ſalt will indeed aſſociate to it ſelf ſome particles of the oil, but will nevertheleſs in their company ſublime in the form of a ſalt, with a very gentle fire. And the example, that *Helmont* ſomewhere gives of arſenick and nitre, does not ſatisfy me, becauſe that when I made equal parts of thoſe two bodies to be mingled, and in a ſtrong crucible fulminated together, a great part of the mixture was driven away by the fire, ſo little altered, that it is very dangerous to be too bold with the fumes, and a good part of what remained was fixt only, in compariſon of the crude arſenick, but not comparably to ſalt of tartar, or ſome ſuch other true alkali: and the conſtancy of the part, that was more fixt, may probably be aſcribed to the ſalt-petre, which we know will, without the help of arſenick, afford a great deal of fixt ſalt, if about half of it be burnt away, by the help of powdered charcoal, or ſome other convenient additament. It may alſo ſerve to weaken this inſtance of *Helmont*'s, that there are other inſtances, in which we may obſerve, that no ſuch thing happens, as his hypotheſis may make one expect. For common ſulphur is by chymiſts ſaid to abound in an oily part, upon whoſe account it is very inflammable, inſomuch that they would have other inflammable bodies to be ſo, by their participating of ſulphur. That this concrete alſo abounds in ſalt, is evident, according to their principles, by the acid menſtruum afforded by it, that goes under the abuſive name of *oleum ſulphuris per campanam.* And yet theſe ingredients, combined by nature, make up a concrete, which is ſo volatile, that both in cloſe veſſels and the open fire, it is almoſt totally volatile. And in that mixture of highly dephlegmed ſpirits of wine and urine, that *Helmont* calls the *Offa alba*, though the urinous ſalts do manifeſtly combine themſelves with the ſpirit of wine, which being totally inflammable, the chymiſts refer to their oil, or ſulphur; yet the coagulated mixture does not, by this aſſociation of ingredients, grow fixt, but proves very volatile. I will not here urge, in favour of the common opinion of the chymiſts of the pre-exiſtence of alkalies in mixt bodies, that a corpuſcularian may ſay two not inconſiderable things; whereof the firſt is, That there is no need of ſuppoſing a colliquation of ſalts with ſulphurs, oils or any thing elſe to produce fixt ſalts; ſince, beſides that that ſuppoſition does not explain, how two volatile bodies come to compoſe one that is fixt, it is plain, that a body yet more fixt may be made without any aſſociation of differing principles. For the earth, that together with the alkali remains in the aſhes of a burnt body, is more fixt than the alkali it ſelf, and yet derives not its fixity from any combination of elements, or principles, but from the groſſneſs, ſolidity, or weight, and unfitneſs for avolation of the corpuſcles it conſiſts of. And the corpuſcularian may add in the ſecond place, that whereas ſome inſtances are alledged, wherein there is ſuppoſed a leſſening of the quantity of the fixt alkali of the concrete, by operations, that are ſaid to carry off the volatile ſalt, before the body comes to be incinerated; it may be anſwered, that perhaps thoſe very operations did but rarefy and volatilize part of the pre-exiſtent alkali, and ſo left the leſs of it to be recovered by burning; as the chymiſts tell us, that fermentation rarifies the oily parts of the juice of grapes, and ſubtilizes them into vinous ſpirits, and ſo does much leſſen the quantity of the oil. And when wood is burnt in a chimney, it is not in the form of an acid ſalt, which is the only, that is commonly obſerved to be driven away by diſtillation in cloſe veſſels, but in that of an urinous ſalt, (which is a-kin to alkalies, and an enemy to acids) that the ſaline part of the wood is made to aſcend; as may appear by the diſtillation of ſoot. Such arguments as theſe a corpuſcular philoſopher might, as I was ſaying, urge in favour of the more received ſpagyrical opinions. But inſtead of inſiſting on them, I ſhall only invite you to take notice of what I obſerve in ſalt-petre. For, though by diſtillation, or any other way, that we yet know, there is no oil to be ſeparated from it; yet above *half* the body of it may be eaſily and quickly turned into a fixt ſalt, in colour, taſte, and operation, much like that of tartar, and other incinerated vegetables. And ſuch an alkali I have made without the help of injected coals, or any other body, furniſhed with a combuſtible ſulphur: ſo that it ſeems not, at leaſt univerſally, true that to the production of an alkali there is neceſſary to be at hand an oil, or ſulphur, to be laid hold on by the volatile ſalt, and fixt together with it. But this experiment is far more congruous to our doctrine, which derives all thoſe ſalts from the ſize, ſhape, and ſolidity or weight of the ſaline corpuſcles; ſince the ſame ſalt-petre, whoſe greater portion may, by the operations newly mentioned, be reduced to a fixt alkali, may, by being diſtilled with a convenient bolus, have its greater portion brought over in the form of an acid ſpirit or ſalt, which it ſelf may afterwards be made materially to concur to the production of an alkali. I might add, that even from one of * *Helmont*'s own experiments, my concluſion may

Vide Blas humanum, N° 41.

Vide Helmontium Complex. atque Miſt. &c

* *Cin's proprio ſuo alkali fit ſal mercum, complex. atque miſt.* N° 12. *Idem Helmontius in Blas humano,* N° 39 *videatur*

may be inferred, ſince he ſomewhere, and, if I miſtake not, in more places than one, affirms, that by the addition of more alcalizate ſalt and the operation of the fire, the earth it ſelf, that is in the aſhes, may be turned into ſalt; which, if true, argues, that a fixt ſalt may be made of that, which was not before, either of ſaline, or of an oleous nature; and conſequently without any ſuch combination of ſalt and oil, or ſulphur, as his hypotheſis ſuppoſes. From which experiment I may alſo infer the poſſible origination of alkalies, by the mechanical changes, that, without the addition of oil or ſulphur, the operations of the fire may produce in the part of a mixt body; ſince earth (excepting water) ſeems the moſt indiſpoſed of any part of the concrete to be turned into fixt ſalt.

I MUST not here pretermit an obſervation, that I have made, which ſeems to overthrow the opinion of thoſe learned chymiſts, who will have the violence of the fire to be always a neceſſary agent, as I allow it to be ordinarily, to the production of a fixt or lixivial alkali. I ſaid ſeems to overthow, becauſe I had not the opportunity to repeat my trials, and am not ſure, that the ſalt I employed was altogether genuine, in regard I cannot here in *London* meet with it, at any rate; but I have great cauſe to think it was right, both for other reaſons, and becauſe it was ſent with other things, for a preſent out of the Eaſt, to an inquiſitive nobleman, who had been lately ambaſſador for his Britiſh Majeſty, at the Ottoman Court, and who was pleaſed as a rarity to preſent it me.

THIS ſalt was affirmed to be the true Egyptian nitre, mentioned ſo much by ancient writers: and indeed I found it to agree much better with the notion, that books had given me of it, than with that ſort, to which chymiſts generally give the name of nitre, and which is indeed the only nitre to be uſually met with in our European ſhops; where it is beſt known by the vulgarly received name of ſalt-petre. But to ſay ſomething of our Egyptian nitre, though it be not pertinent to mention here all that I obſerved about it, yet I muſt not here omit two things, that I made trial of, with that little, which eſcaped the misfortune that loſt me all the reſt, that ſeem conſiderable in the preſent occaſion.

THE firſt whereof is, that this Nilotick ſalt was very apt to imbibe the moiſt air, as calcined tartar and other fixt alkalies are wont to be; to which reſolution we do not find our ſalt-petre, if it be unmixed, diſpoſed. But the other and more important thing I obſerved, was this, that having upon this Egyptian nitre, crude as it was, poured ſpirit of ſalt, this acid liquor did preſently, even in the cold, work briſkly upon it, as if it were a fixed alkali, or at leaſt abounded with ſuch a lixivial ſalt. And here, upon the by, give me leave to take notice of a text of the holy Scripture, that has ſometimes puzzled not only me, but far better criticks in the Hebrew tongue than I. And it is a paſſage to be found in the 25th chap. of *Solomon*'s Proverbs, where, to illuſtrate things very incongruous to one another, the diſagreement of vinegar and nitre is mentioned; for ſuppoſing the words to be rightly tranſlated, as beſides the authority of I know not how many verſions, the very ſound of the Hebrew word *næter* or *næthar* argues it to be, it ſeems very hard to find, what ſhow of antipathy there is between vinegar and the ſalt-petre, that is commonly ſold in our ſhops for nitre. Wherefore ſtrongly preſuming, that *Solomon*, who reigned in *Judæa*, a country near to *Egypt*, and had much commerce with the Egyptians, whoſe King's daughter he had married, made uſe of Egyptian nitre as the beſt known, if not the only in his time and country; and might have found in this nitre ſome quality very differing from any we find in our ſalt-petre; as I remember, that in the Prophet *Jeremy* nitre is mentioned as a very abſterſive thing, and fit to cleanſe women's ſkins, which is a known virtue of our fixed alkalies, but not obſerved in pure ſalt-petre: wherefore when once I received the nitre, that I have mentioned, and ſaw in it ſigns of an alkalizate nature, I quickly poured upon it ſome ſtrong vinegar, and found, as I expected, that there preſently enſued a manifeſt conflict, with noiſe, and ſtore of bubbles; with which experiment I afterwards acquainted ſome criticks, and other learned men, who were not ill pleaſed with it. But this theological uſe of the alkalizate nature of nitre not being that, which I chiefly mentioned it for, I ſhall now make the philoſophical uſe I intended, by taking notice, that Egyptian nitre being acknowledged to be a native ſalt, and made only by the evaporation of the ſuperfluous water of the *Nile*, (or ſome other ſuch liquor) is yet of a lixiviate nature, or at leaſt abounds with particles that are ſo: though, as I freſhly intimated, it was produced without any precedent incineration, and the matter of it ſuffered not, or at leaſt needed not ſuffer any violence of the fire to make it afford an alkali. Jer. ii. 22.

I HAVE repreſented theſe things, not for that I pretend to be ſure, that alkalies may not be produced in multitudes of mixt bodies, eſpecially in a good number of vegetables, after the way propoſed by *Helmont*, or by ſome ſuch like; but partly, becauſe it ſeems not always neceſſary to the exiſtence of an alkali in nature, and to be the only way it can be produced by; and partly, becauſe I would give you and your chymical friends occaſion to clear (as far as they can) and confirm the doctrine I have queſtioned. It is true, that being a far greater friend to truth, than an enemy to the chymical hypotheſis, I would not ſtifle what may ſerve to advance that, in favour of *Helmont*'s doctrine, though this would never ſo well accommodate my preſent argument. But I have no great temptation to ſurmount in this caſe, for it concerns very little the main ſcope of this diſcourſe, whether *Helmont*'s way, or any other, of the production of alkalies be embraced; ſince it will ſuffice for my purpoſe, if ſome bodies belonging to this family, or kind of ſalts, may be produced: I ſay ſome, becauſe (as I have already intimated) I will not peremptorily aſſert, that all fixed alkalies are productions of

the fire, or made by the help of it; though I do not readily remember, that I have met with any (except Egyptian nitre) that are not. But I ſhall wave that queſtion, becauſe my intended brevity calls upon me to proceed to the mention of ſome particular inſtances, fit to perſuade us, of the producibleneſs of ſome alkalizate ſalts.

IT is known, that chymiſts generally look upon ſpirit of nitre and aqua fortis, as liquors containing not alkalies, but acid ſalts; which they conclude not only from the taſte, but from the great ebullition, that is made, when thoſe liquors are poured on the ſalt of tartar, fixed nitre, pot-aſhes, or other ſuch unqueſtioned alkalies. That ſea-ſalt likewiſe does not contain alkalies, is generally taken notice of, the ſpirit of it being juſtly reckoned among the acid ones; and when I purpoſely examined that concrete by diſtillation, the remaining ſalt, though the fire had been violent, was very differing from alkalies: and yet my conjectures inclining me to ſuſpect what the event would prove, I ſeveral times made the following experiment upon ſea-ſalt, that yet retained all its acid ſpirit in it.

UPON well dried and powdered ſea-ſalt we put into a retort ſometimes an equal, and ſometimes (which I prefer) a double weight of good ſpirit of nitre, or aqua fortis, and leiſurely diſtilling all that would come over, we took out the dry ſalt remaining at the bottom, which we found much changed both as to colour, (a good part of it being uſually very reddiſh) and as to taſte, which was differing enough from what it had been before, and might probably have been made much more ſo, if freſh ſpirit of nitre had been once or twice more abſtracted from it. This ſalt being again powdered (for it was in a lump when taken out) and put into a crucible, placed in a convenient fire, was by the repeated injection of fragments and well kindled charcoal made to flaſh divers times almoſt like melted nitre; and when it would flaſh no longer, the remaining matter being taken out, did, in great part, appear to be brought to an alcalizate nature, for it had a fiery taſte upon the tongue: if ſpirit of nitre or aqua fortis were poured on it, it would make an ebullition, it would turn ſyrup of violets green, and, in ſhort, exhibit divers phænomena of alkalizate ſalts.

ANOTHER way there is like that mentioned of making an alkali out of nitre, which is thus done; pour upon it an equal weight, or half the weight of ſtrong oil of vitriol; and having diluted the mixture with a convenient proportion of fair water, diſtil it by degrees, till there remain a ſubſtance very dry. Powder this, and mix it well with about an eighth part of beaten charcoal; keep them in fuſion in a ſtrong and covered crucible, till the maſs grow very black, and a little of it being taken out with a wire, taſte fiery upon the tongue, (which may happen in about half an hour or an hour, according to the quantity of matter, and degree of fire:) then take out the blackeſt or deeply red mixture, which will very eaſily imbibe the moiſture of the air, and you may find it, at leaſt while it is hot and dry, of a more fiery lixivial taſte than ſalt of tartar itſelf. It will make an ebullition with acid ſpirits, and precipitate divers ſolutions made with them; it will turn ſyrup of violets green, and in ſhort diſcover itſelf many ways to be of an alkalizate nature, though it be aſſociated with a ſulphur, that may, by divers methods, be made appear to be contained plentifully in it.

IT is alſo conſiderable on this occaſion, how the ſame body, without the addition of any other ſalt, may by the various manner of the fire's application to it be made to afford, either little elſe than acid ſalts, or a leſſer or greater quantity of alkali: for if fine ſalt-petre be dexterouſly diſtilled with about thrice its weight of ſome fit earth, (but not, as is uſual, with powdered bricks) it will ſometimes afford very near as much ſpirit of nitre as the ſalt weighed; and though this, like other liquors, be not without phlegmatick parts, yet beſides that it may be doubted, whether moſt or many of them were not produced by the tranſmuting operation of the fire, we may ſuppoſe, that five parts of ſix, or ſix of ſeven have been diſtilled into dephlegmed ſpirit.

BUT if, according to the way I have elſewhere * circumſtantially delivered, (which is by frequent injecting into fluxed ſalt-petre ſmall pieces of kindled charcoal, till one can make it flaſh no more at all,) you make fixed nitre, you may obtain from nitre thus handled half its weight, and perhaps better, of an alkalizate ſalt, that many would, by its taſte and operations, gueſs to be ſalt of tartar.

BUT to ſhew yet further, how much the production of this alkali depends upon the operation of the fire, which, as it is variouſly applied, may vary the texture of the ſalt-petre, my conjectures led me to try the following experiment, which I did with ſucceſs from the beginning. We took a pound of good ſalt-petre, which was but groſly beaten (for it ſhould not be finely powdered) and having laid it on a conical heap upon a flat tile, that the air might on all ſides have acceſs to it, we cauſed the upper part of it to be kindled by a little fragment of burning coal, (which may be afterward thrown away.) Then we cauſed the laborant with an iron rod dexterouſly to ſtir the kindled part of the nitre, that the ignition might be preſently communicated to as many parts of the ſalt, as was poſſible; and this nimble ſtirring of the maſs, that the fire might be more diffuſed, and more parts might be obverted to the air, we cauſed him to continue to the end of the operation: by which method, within few minutes, we obtained, more than once, out of ſixteen ounces of ſalt-petre, about ten ounces or better of fixed nitre, very lixivial in taſte and operation; and for the colour, it was of a pleaſant greeniſh blue, and deeper than ſalt of tartar will uſually be brought to, by being (in a crucible) kept twenty times as long, in a good fire.

THE other ſcopes and uſes deſigned in this new and quick way of making the alkali of nitre

* In the *Eſſay of the differing Parts and Reintegration of Nitre.*

nitre belong to another diſcourſe, the experiment, which will ſcarce ſucceed without a dextrous management, being here mentioned to ſhew, what quantity of alkalizate ſalt may by a differing operation of the fire be obtained from nitre; which (crude nitre) in diſtillation ſkilfully made for the purpoſe may be in great part driven over, in the form of acid ſpirit, and phlegm, and leaves ſo little true alkali behind it, that I have wondered at it, being ſometimes ſcarce able to find any at all, though I purpoſely tried to ſeparate it from the tobacco-pipe clay, which the petre had been mixed with after a diſtillation, wherein not half of the ſalt had been driven into the receiver, in the form of ſpirit.

AND to ſhew, that to make the fixed ſalt of nitre, the actual inflammation of it, in the open air, is not neceſſary, as very learned men have ſuppoſed; and that it is poſſible, whatever is preſumed to the contrary, to make an alkali nitre, though charcoal, or ſome other combuſtible body be not added to it, to kindle the corpuſcles of the nitre by its ſulphur, and by the aſſociation of ſome part of the ſame ſulphur with the ſaline parts of the nitre, to compoſe an alkali; to ſhew this, I ſay, I more than once made the following experiment: With a convenient quantity of good ſalt-petre we carefully mingled about an eighth part of tobacco-pipe clay; and putting the mixture into a crucible cloſely luted at the top, we kept it by a fitly graduated fire in fuſion for ſome hours, and found, as we expected, that the remaining ſalt, (for part would get through the lute, or commiſſures in the form of fumes) was turned into an alkali, of a fair blue colour, like the better ſort of that fixed nitre, which is made with charcoal. This experiment, and that formerly made with tobacco-pipe clay, ſeem plainly to argue, that to the making of fixed nitre, which is confeſſed to be an alkali, a congruous change of texture may ſuffice; whether that change be attempted to be made in open veſſels, or in cloſe ones, with, or without the addition of the ſulphur of charcoal, or any other ſuch combuſtible body. Upon the ſame ground, that I had for trying the former experiment, I attempted, and not without ſucceſs, to make an alkali of ſalt-petre, by colliquating moderate quantities of it, ſeveral ways, (and keeping it in fuſion) with ſome metals: I ſay, moderate quantities of nitre, becauſe an ingenious gentleman, to whom I communicated this practice, could not make it ſucceed in any conſiderable quantities. And to obviate the ſuſpicion, though perhaps groundleſs, that ſome chymiſts might have of the material concurrence of a good portion of the combuſtible ſulphur, preſumed to be in the ignobler metals to the production of the nitrous alkali; I ſhall add, that our experiment ſucceeded, when we tried it more than once, with more than ordinarily fine ſilver, whoſe ſulphur, if it have any, is granted to be fixt or incombuſtible. And I remember the laſt trials afforded us a bluiſh alkali, though there were employed but a fifth part of ſilver, in reference to the nitre; and though the fire (which was continued for ſome hours) was ſo moderate, that the metal, though thinly laminated, was not melted; and of an ounce, that was put in, there wanted but four grains, which ſmall loſs might eaſily be imputed to divers accidents.

AFTER what is ſaid of the production of lixiviate ſalts and alkalies, it will not be impertinent to add, that as they may, by the operation of the fire, be produced; ſo by the operation of the fire they may be deſtroyed or deſpoiled of their alkalizate form, and turned into a ſubſtance of a nobler nature. This I am induced to think very probable by ſome experiments, amongſt which, that which ſeemed the moſt conſiderable, was this: we took a pretty quantity of good ſalt of tartar, that had been purified by ſolution and coagulation, and having put it into a clean crucible, we kept it in a ſtrong fire (that made the crucible red-hot) for a good while; then giving it at length a ſtronger fire, we poured it or (afterwards) took it out of the pot, and diſſolved again as much of it as we could in cold water, which being ſet to run through cap-paper, there appeared, as I foreſaw, in the filtre a pretty deal of matter, that would not (as the whole ſalt had done at firſt) be diſſolved in the water, but was turned into a kind of earthy ſubſtance. Then coagulating again the ſolution, that had paſſed through the filtre, into dry ſalt; we expoſed it again in the crucible to a ſtrong fire, and putting it again into water, we perceived it would not totally diſſolve, but left in the filtre a ſlime or mud. And in this manner we proceeded to ignite, diſſolve, filtre, and coagulate the ſame ſalt of tartar many times; for, if I much miſtake not, it was ſixteen times, and ſtill found ſuch an earthy ſubſtance as has been ſpoken of, remaining in the filtre; and the reſt of the ſalt of tartar ſo little altered, that being ſomewhat tired, and other ways diverted, I deſiſted from proſecuting the operation to the uttermoſt; concluding it highly probable, that the remaining ſalt might, by the ſame way of management, be brought to yield more and more of that ſame ſubſtance, which either was earth, or of kin to it, being at leaſt ſomewhat, that was of a nature very differing from ſalt of tartar, ſince it was not like it, fiery on the tongue, and was indiſſoluble in water, as earth, but not ſalt of tartar, is known to be.

SECT. IV.

IT may bring ſome illuſtration, and add ſome probability to what has been diſcourſed about the producibleneſs of ſalts, if we conſider what happens in the compoſitions and decompoſitions of ſaline particles, and their operations on other bodies, and on one another. For if it appear, that, by theſe manifeſt and mechanical ways, ſuch alterations may be made, and ſuch qualities produced, as are either altogether, or very near as conſiderable, as thoſe, which diſcriminate the ſeveral families of ſalts, formerly ſpoken of, from one another, and from this or that chymical principle; it will, I preſume, be judged the more credible, that theſe families

lies of ſalts may be either tranſmuted into one another, or otherwiſe produced; and ſo may not be primordial and immutable beings, in the ſenſe, wherein the chymiſts would have them to be ſuch. I have elſewhere taken notice of the production of vitriols, ſal armoniac, borax *, and divers other factitious ſalts; for which reaſon; I ſhall not inſiſt on them here the rather, becauſe it may ſuffice for my preſent purpoſe to take notice of two ſalts, whereof the one is meerly factitious, and the other ſuch in great part; and yet each of theſe, by a very ſlight and eaſy way of ordering it, afforded me differing ſaline concretions, ſome of which reſembled a ſalt, which many judge the moſt ſimple and natural, that we yet know of.

To ſhew then, that common ſalt itſelf, that ſeems the moſt primitive and ſimple amongſt groſs and viſible ſalts, may be produced by a change of texture made in bodies very differing from common ſalt, I ſhall recite an experiment, which though it have ſometimes failed me, yet it has divers times anſwered my deſire, though I ſhall now relate but that ſingle one of my laſt trials, that ſucceeded beſt.

THAT, which our Engliſh glaſſmen call *fandever*, and the French, of whom probably the name was borrowed, *ſuindever*, and is, you know, that recrement, that is made, when the materials of glaſs, namely ſand and a fixt lixiviate alkali, having been firſt baked together, and then kept long in fuſion, the mixture caſts up the ſuperfluous ſalt, which the workmen afterwards take off with ladles, and lay by as little worth; this ſalt ſeldom uſed by mineraliſts, and ſcarce wont to be mentioned by the writers of courſes of chymiſtry, I have thought fit to employ about ſeveral purpoſes, invited thereto by conſidering the uſual way, wherein it is produced. For in ſandever we have a ſalt, which was once altogether lixiviate, but which having been kept long melted in a ſtrong fire with ſand (or flints or pebbles) muſt have had its ſaline corpuſcles variouſly and forcibly ground or rubbed againſt another, and againſt the particles of the ſand, ſome of which it may alſo have diſſolved and retained with it; by which rude juſtlings and mutual attritions, I thought it very probable, that the alkali muſt not only have been conſiderably altered, but variouſly too, ſome parts being changed more and after a differing manner than others, by which means ſandever may conſiſt of portions differingly qualified both in reference to the lixiviate ſalt, that was at firſt employed, and to one another.

WE took a pretty quantity of good ſandever, and having diſſolved it in fair water, and filtred it, we ſet it to evaporate in a digeſtive furnace, till a ſaline cruſt, as if it were a thin plate of ice, ſpread it ſelf upon the top of the liquor; then ſuffering it to cool and cryſtallize, we broke the mentioned cover, to come at the cryſtals, and ſet the liquor we had poured off from them to evaporate further and ſhoot again: and in this method we proceeded, whilſt we judged worth while to do ſo. By this means we obtained good ſtore of cryſtals, whoſe figures were not the ſame, but many of them differing enough, though moſt of them tranſparent and prettily ſhaped, as if nature had at once affected variety in their figuration, and yet confined her ſelf to geometrize. But the chief thing, for which I mention this experiment, is, by this way of proceeding, I more than once obtained (not on the very ſurface of the water, as is uſual in the concretion of ſea-ſalt) but in other parts, and chiefly beneath the ſurface of the ſaline plate formerly mentioned, a conſiderable number of grains of ſalt, that better anſwered to the deſcription of common ſalt, than diſſolved and filtered ſea-ſalt it ſelf is wont to do: for theſe grains, that were of no deſpicable bigneſs, were as like little cubes or dice, as if they had been made by a ſkilful jeweller; and their ſurfaces had a ſmoothneſs and gloſſineſs much ſurpaſſing whatever I had obſerved in marine or common ſalt.

I MAY confirm the difference, I have mentioned to be between ſandever and common alkalies, if I here add, that ſome while ago having ſet a good quantity of filtered ſolution of ſandever to coagulate in a cool place, and thereby brought a great part of the ſalt to coagulate into cryſtals, almoſt like thoſe of nitre, but ſo very diaphanous, that divers them were clear as rock cryſtal it ſelf; I did not obſerve them to relent by the moiſture of the air in a long time, though the glaſs they were kept in were negligently enough covered with paper only; which argues their texture to have been remote enough from that, which is proper to alkalies: and to ſhew, that they were alſo ſalts of a peculiar nature, I ſhall further obſerve, that if they were expoſed, though but to a gentle heat, they would in no long time loſe their tranſparency, and be reduced to a white and fine calx; which being weighed and re-diſſolved in water, and made again to cryſtallize, would be diaphanous, and concoagulate with it ſelf ſo much of the water, as ſufficed to give a very notable increaſe of the weight.

SANDEVER, which afforded me the firſt of the two inſtances I promiſed you of the production of ſalts, is one of thoſe bodies, that many would reckon amongſt thoſe, that are almoſt meerly artificial. I ſhall now mention a ſecond inſtance of a body, wherein art ſeems to have little to do, ſave the eaſy extrication of its particles from thoſe, wherewith nature had blended it in a human body. If then man's urine, after having been kept ſome weeks in a cloſed veſſel, be expoſed to a moderate fire, firſt it will yield a ſpirit and a volatile ſalt, and then a very copious phlegm, which being totally exhaled, there will remain a dry *caput mortuum*; and this being warily calcined, diſſolved in water, and coagulated, if the experiment ſucceed with you, as it did with me, you will find the ſalt very different from a common lixiviate alkali, rather you will find ſaline concretions of differing forms, if not kinds: for I obſerved ſome to be oblong, and to look like ſmall cryſtals of nitre; others, to be of figures reſembling thoſe, that geometricians call *Rhombus's* or *Rhomboides*; and one of the faireſt of theſe

* In the *Eſſay of the Uſefulneſs of Chymiſtry to the Empire of Man.*

theſe lozenges, I remember, for trial-ſake, I kept for many days expoſed to the air, and that in winter, without finding it run *per deliquium*, as a piece of common alkali of that bigneſs would have done in a little part of that time. But beſides thoſe numerous ſaline concretions, that I could not eaſily reduce to any known figure, there was (which I chiefly expected, and would have you take notice of) a conſiderable number of fine grains, that looked like common ſalt, and were indeed more exactly cubical in their figure, than the grains of ſea-ſalt themſelves are wont to be. And I have the leſs cauſe to doubt, that the ſea-ſalt abounding in our *caput mortuum* was not a common lixiviate alkali, but conſiſted of parts of other natures, eſpecially of ſuch as compoſed ſea-ſalt; becauſe I obſerved, that the *caput mortuum*, when expoſed to calcination, began early to melt in the fire, before it was near calcined, as not an alkali, but ſea-ſalt, would have done; alſo becauſe the taſte was much nearer to that of brine, than to that of lixivium; and becauſe, laſtly, it would make no conflict with the ſpirit of ſalt, as an alkali would have done, but did make of a ſolution of ſilver in aqua fortis a white precipitate, like that we make of that metal with ſea-ſalt, but not with alkalies.

AND becauſe a miſchance unſeaſonably deprived me of the *caput mortuum* of domeſtick urine, prepared in my own laboratory, I was fain to procure a ſupply of fixt ſalt of urine made by a diligent Spagyriſt of my acquaintance, who had wrought much upon that liquor, and having diſſolved and filtered a pretty quantity of this ſalt, and ſuffered the ſolution to evaporate ſlowly, till it began to have a ſkin, I found the cryſtals it afforded in a cool place to be ſome of them an inch or two long, and ſhaped almoſt like cryſtals of nitre, ſave that they were ſharper at both ends, and to many of them were faſtened ſtore of minute and oblong cryſtals prettily ſhaped, which were placed almoſt perpendicularly upon the greater portions of ſalt, which by this means obtained a ſhape, not much unlike that, which the *French* engineers call *cheval de friſe:* theſe cryſtals, as they did not reſemble common alkalies in their figures, ſo they were unlike to them in divers other reſpects. For though ſome oil of tartar *per deliquium* being poured upon ſome of them, there enſued no manifeſt commotion, as is wont to be produced, when that liquor is mixt with a ſalt, where an acid is predominant, yet being beaten and mixt with an acid ſpirit, as that of common ſalt, they made not the leaſt ebullition or conflict, though they were ſtirred up and down to excite it; nor did aqua fortis, good enough to be worthy of that name, produce any hiſſing noiſe or froth, when it was put upon the ſalt of urine, though at length it diſſolved a good proportion of it. And though ſtrong oil of vitriol being put upon ſome of the forementioned cryſtals, did readily work upon them, and in corroding them excite a good number of bubbles, yet that did not ſurpriſe me, nor make me conclude the ſalt to be alcalizate, becauſe I have obſerved oil of vitriol (tho' not ſpirit of ſalt or aqua fortis) to work after the like manner upon common ſalt, of which that the fixt ſalt of urine did participate, I judge very probable, partly upon the account of the phænomenon newly recited, partly becauſe I found, that by impregnating good aqua fortis with a competent quantity of the fixt ſalt, inſtead of diſſolving in it ſea-ſalt, I could make it capable of corroding foliated gold, even in the cold; and partly alſo, becauſe that ſome part of the ſolution of our fixt ſalt, that was more ſlowly coagulable, being mixt with oil of tartar, preſently grew thick and muddy, and ſoon after let fall a precipitate copious enough: and another part of the ſame ſolution did readily precipitate ſilver diſſolved in aqua fortis, but would not ſo much as diſcolour a ſtrong ſolution of ſublimate, (made in fair water) from which a common lixiviate alkali would have immediately ſtruck down an orange-coloured powder.

A LIGHT ſuſpicion I once had, that the common ſalt, that moſt men eat to ſeaſon their aliments, may in ſome degree impregnate men's urine, gave me the curioſity to examine that of horſes, which I found to require rather a ſhorter than a longer putrefaction than human urine, to make it fit for diſtillation; but the *caput mortuum* of this alſo, I was by an accident hindered to examine ſufficiently: but by the ſpirit and volatile ſalt the liquor after putrefaction eaſily afforded, it ſeemed probable enough, that the fixt ſalt would have been not unlike that of men's urine. Of which laſt named olid and deſpicable liquor I choſe to make an inſtance in this place, becauſe chymiſts are not wont to care for extracting the fixt ſalt of it, (which is therefore commonly preſumed to be like other alkalies;) but as ſoon as they have diſtilled the ſaline ſpirits, throw away all the reſt as nothing worth. Which practice, as general as it is, I cannot commend; for though I am not altogether of *Helmont*'s mind, where he ſays, that *Wiſdom deſpiſes thoſe, that deſpiſe the indagation of urine, and refuſe by the fire to ſearch out its contents*; yet I think, that thoſe, who underſtand the myſtical writings of ſome of the beſt chymical philoſophers of former times, will look upon it as a more tolerable hyperbole, than other men or even vulgar chymiſts imagine it to be.

OF THE PRODUCIBLENESS OF SPIRITS.

PART II.

SECT. I.

Of the production of vinous ſpirits.

AS for what the chymiſts call ſpirit, they apply the name to ſo many differing things, that this various and ambiguous uſe of the word ſeems to me no mean proof, that they have no clear and ſettled notion of the thing. Moſt of them are indeed wont, in the general, to give the name of ſpirit to any diſtilled volatile liquor, that is not inſipid, as is phlegm, or inflammable, as oil. But under this general term they comprehend liquors, that are not only of a differing, but muſt be, according to their principles, of a quite contrary nature; ſome of them being acid, as ſpirit of nitre, of ſalt, and of vinegar itſelf; and ſome of them urinous, or, as ſome would have it, volatile alkalies, which are ſuch enemies to the former, that, as ſoon as they are put together in due proportions, they tumultuate and grow hot, and uſually continue to fight, till they have diſarmed or mortified each other. Beſides theſe two hoſtile families of ſpirits, there is a third ſort, which they call vinous or inflammable, which though very ſubtile and penetrant, is not manifeſtly either acid, or alkalizate; I ſay, manifeſtly, becauſe the taſte and ſmell of this ſort of ſpirit is differing from both the ſorts laſt named; and yet is referred to one, or the other of them, by ſome learned Spagyriſts; with whom I neither need, nor deſire to diſpute about this matter; ſince it may ſuffice for my purpoſe, if it can be made out, that all the three ſorts of ſpirits above mentioned, the vinous or inflammable, the urinous or alkalizate, and the acid, may be produced, and conſequently may be other than primeval bodies.

AND to begin with the firſt named, theſe vinous ſpirits are ſo producible by art, that we ſeldom find them produced by nature alone, which does indeed make the juice of grapes, but does not make wine, nor the ſpirit of wine, unleſs, by the help of man, that juice be preſſed out, and fermented. And the caſe is yet more plain in the ardent ſpirits made of ale, beer, and in the like vinous ſpirits made by the decocting and fermenting the ſeeds and other parts of vegetables. And it is obſervable to our purpoſe, that muſt (or the juice of grapes newly preſſed out) does not in diſtillation yield a vinous and inflammable ſpirit. And I remember, I had once the pleaſure to laugh at a man, otherwiſe very ingenious, who, to catch the ſubtile vinous ſpirit, that he would have me think was loſt in the common way of handling wort, made it work in a huge copper limbeck, to catch the ſpirituous parts, that he thought would otherwiſe fly away; by which means, inſtead of the ardent ſpirit he expected, he got nothing in his receiver but a nauſeous phlegm. I have alſo found by trial, that raiſins (which we know are but dryed grapes) being diſtilled alone, afforded an acid and empyreumatical, but not a vinous ſpirit; whereas, when I carefully fermented them with a due proportion of water, they would afford me in diſtillation an ardent ſpirit like that of wine.

IF it be objected, as I preſume it will, that the vinous and inflammable ſpirit, that is by fermentation obtained from bodies, was actually in them before, and is only extricated by fermentation; I anſwer, that this is *gratis dictum*, and is therefore not to be admitted till it be proved; ſince raiſins, and ſuch other fermentable bodies do not, upon the ſuppoſed analyſis made by diſtillation, afford a vinous ſpirit, but one that is very differing from it. And I ſee not, why the change of texture may not turn ſome part of the juice of grapes into a vinous and inflammable liquor, ſince a little further change is able to turn the ſame juice into a liquor, that is acid, and neither vinous nor inflammable, as it was before. And I have found by trial, that even this vinegar, crude as it is, being ſatiated with calx of lead made *per ſe*, would afford a ſpirit not acid, but of a very differing taſte, and inflammable, like the ſpirituous parts of wine. And if it ſhould be further objected, that theſe inflammable ſpirits were not produced by theſe operations, but pre-exiſting in the newly expreſſed juice of grapes, were only extricated by fermentation, and being afterwards covered or diſguiſed by the acid particles of the vinegar, were again extricated by diſtillation, the acid ſalts having fixt themſelves upon the lead they corroded, and thereby given the ſpirits leave to forſake them: if I ſay, this be objected, I might refer you to a more full anſwer, that I have elſewhere given. And at preſent it may ſerve the turn, that I put you in mind again, that the objection alledges no phænomena to make appear the actual pre-exiſtence of vinous ſpirits, either in the juice of grapes, or in the ſolution of lead.

AND though I need but deny what is barely affirmed, not proved; yet to examine this matter further than I had found others to have done, I did (as I elſewhere mention) make a *ſaccharum Saturni* with an acid liquor made without fermentation, or the addition of any liquor from wood itſelf; and then, diſtilling it alſo without any additament, I had, (as I expected) a ſpirit, that readily took fire and burnt away in a blue flame, like that of ſpirit of wine. I know another objection may be framed from the doctrine of ſome chymiſts, who would have ſpirit of wine to conſiſt of the oily parts of the juice of grapes rarefied and ſubtilized. But with theſe learned men (for ſuch I know ſome of them to be) I have not here any need to enter into a diſpute; ſince, without

without examining, whether their opinion be true or no, if it be admitted, it will be conſiſtent enough with mine. For to ſay, that by ſubtiliation, rarefaction, a peculiar kind of commixture with the phlegm, or the like means, the oil contained in the juice of grapes, (and ſeparable from it, in the form of oil, if it be diſtilled before it be fermented,) becomes ſpirit of wine, is but to aſſign the modus, whereby vinous ſpirits are produced, but not to deny their production. And all that my purpoſe requires, is, that it be proved or granted, that inflammable ſpirits are really produced, by what way ſoever they come to be ſo. I ſhall add, that though experience witneſſes, that honey being ſkilfully fermented with a due proportion of water, will yield a greater plenty of inflammable ſpirit than the wine itſelf, that is made in divers countries; yet when we have carefully diſtilled honey before fermentation, it afforded us a great proportion of conſiderably acid ſpirit, that would diſſolve ſome metals, but ſo little oil, that the paucity ſeemed ſtrange, and made it appear unlikely enough, that ſo inconſiderable a proportion of that liquor ſhould be rarefiable into ſo much ardent ſpirit, as may be obtained from well fermented honey.

SECT. II.

Of the production of urinous ſpirits.

I PROCEED now to the other ſort of ſpirits, as thoſe of hartſhorn, blood, ſal-armoniac, ſoot of wood, *&c.* that we have formerly called urinous, becauſe of their great affinity in many qualities to the more familiarly known liquor, ſpirit of urine. But as for theſe, I know not, whether it will be neceſſary to treat of their origin apart; ſince, for aught experience has yet aſſured me, theſe ſpirits are not ſimple, but compounded bodies, conſiſting of the volatile ſalt of the concrete, that afforded them, diſſolved in the phlegm, and for the moſt part accompanied with ſome little oil, at firſt undiſcerned by the eye, though afterwards it grow viſible. The preſence of this oil in moſt ſpirits, belonging to this family, may be probably argued from the deep tincture, that in proceſs of time, ſpirit of hartſhorn, of blood, and divers other ſubjects, will acquire by ſtanding, though preſently after their diſtillation, and firſt or ſecond rectification, they were clear, and colourleſs as water; the oily portion, which, whilſt it was in very minute particles, lay concealed in the mixture, becoming diſcoverable in proceſs of time by their extricating themſelves a little, and aſſociating, though not ſo far as to emerge and float, yet far enough to diſcloſe themſelves by the colour they give the liquor. But in ſpirit drawn by the help of an alkali from ſal armoniac, a concrete not abounding in oily parts, like hartſhorn, blood, *&c.* kept not only for many months, but divers years, I obſerved no ſuch diſcolouration; which was one inducement to make me, in ſpeaking of the oleaginouſneſs of urinous ſpirits, to employ the word *moſt* rather than the word *all*.

HAVING therefore hitherto by rectifications and digeſtions obſerved nothing in theſe urinous ſpirits but a cryſtalline volatile ſalt, moſt commonly ſeparable in a dry form, and the phlegm it was diſſolved in, beſides ſome oleaginous particles, that had (though at firſt unperceivedly) aſſociated themſelves to it; I ſee no great need to trouble you with particular inſtances about this ſort of ſpirituous liquors; what has been ſaid, making it allowable for me to refer you to what I deliver about the production of ſalts, where that of volatile ones is mentioned.

SECT. III.

Of the production of acid ſpirits.

AS for acid ſpirits, that ſome of them may be generated or produced *de novo*, ſeems probably deducible, partly from what has been already delivered (in the firſt part of theſe notes) concerning the production of acid ſalts; and partly from what will be ere long recited of acid, as well as of urinous and of vinous ſpirits, obtained by diſtillation from one and the ſame body. And if we take the word acid, as I uſually do in theſe notes, in a familiar ſenſe, without cryptically diſtinguiſhing it, from thoſe ſapors, that are a-kin to it, perhaps the ſpirit of ſea-ſalt and that of nitre may be fitly enough propoſed, as inſtances of the production of acid ſpirits. For though ſea-ſalt and its diſtilled liquor have upon ſome bodies the like operations, as either of them will precipitate ſilver out of aqua fortis, yet not only the taſte of the ſpirit of ſalt (eſpecially that which riſes laſt in diſtillation) is exceeding different from that of crude ſalt, not only in ſtrength and penetrancy, but in this, that the ſpirit is highly acid. Whereas the crude ſalt has a taſte not properly acid, but that, which by a diſtinct name is in Latin commonly called *ſalſus*, ſuch as that, which predominates in brine; and it does not appear, that this acid ſpirit did as ſuch pre-exiſt in the ſalt, whence it was obtained, ſo that we may ſuppoſe it to have been made rather by tranſmutation than extrication. And the like, I think, may (and that with greater probability) be ſaid of the ſpirit of nitre; for though this be highly acid, yet the nitre, that afforded it, is not at all ſenſibly acid: and this new vehement taſte of the ſpirituous parts, as well as their great efficacy in diſſolving metals, and divers other bodies, ſeems to have been produced by the violent action of the fire, (agreeably to what I formerly noted) which by cleaving the nitrous *Part I.* corpuſcles, or by rubbing them one againſt another, or by both theſe ways, and perhaps by ſome others, makes a comminution of them into fragments or particles, which both becauſe of their ſmallneſs and lightneſs may be elevated by the action of the fire, and becauſe of the ſame minuteneſs and their ſharp and pointed figures may get into the pores of many other bodies, and divide their parts. I know, that chymiſts may object, that all the acid ſpirit, that can be diſtilled from nitre, was really pre-exiſtent in it, and only clogged and diſguiſed by the alkalizate ingredient, wherewith it was aſſociated, as may appear by what I my ſelf relate of the ſpeedy way of making

ſalt-petre, by putting a due proportion of the ſpirit of nitre to the alkali, or fixt part of nitre, that remains after the ſalt-petre has been fulminated or burned. But to this I anſwer, that this proves indeed, (what I readily grant) that ſalt-petre may be artificially compounded of a nitrous ſpirit and a fixt alkali, but does not prove, that nature does always, or ſo much as ordinarily produce nitre by the ſame ways, that is, by compounding it of the ſame ingredients. For it does not appear, that where-ever ſalt-petre is generated in the earth, nature has before-hand laid in a proviſion of lixiviate ſalt, which (at leaſt, in theſe countries) is not wont to be made without the violence of an incinerating fire and of corroſive ſpirits, to obtain which, or either of them, artiſts are fain to employ vehement fires; whereas it ſeems, that ſalt-petre is ſlowly generated in the earth by gradual or ſucceſſive alterations of ſome idoneous matter, wherein, for aught I have obſerved, not an acid, but an urinous ſalt is predominant; as may be made probable by what I have formerly related about earth, that had long lain covered with pigeons-dung in a dove-houſe, which I found in diſtillation to yield a volatile ſpirit and ſalt, much like thoſe of urine. Therefore I will not affirm, that nature does never employ fixt alkalies and acid ſpirits to make ſalt-petre; yet I ſee not, that chymiſts have hitherto given us, or perhaps offered us any cogent proof, that ſhe muſt neceſſarily do ſo. I further obſerve this more conſiderable argument, that, according to what I formerly noted, ſalt-petre diſtilled in cloſe veſſels afforded us but an inconſiderable quantity of fixt ſalt, and that too was but a very imperfect alkali; though the quantity of nitrous ſpirit was great enough to perſuade us, that not any thing near ſo much as was wanting of the entire weight of the ſalt-petre had paſſed into the receiver. And elſewhere I relate, that a friend of mine, with the help of a peculiar clay, obtained near a pound of ſpirit of nitre from a pound of ſalt-petre; whereas, on the other ſide, by a differing way of managing it, and without additament, I obtained, as I there relate, about ten ounces of fixt nitre from a pound of ſalt-petre. Whence it ſeems probable, that the ſame ſubſtance, that in crude nitre is almoſt inſipid, may by an operation of the fire be diſtilled into a highly acid ſpirit, as well as, by another operation and way of management, be brought into the nature of a fixt and cauſtick alkali. It may alſo be worth conſidering, whether the ſpirits of nitre themſelves, when after being made *ſui juris* they compoſe a diſtinct liquor, and are ſpecificated, may not be deprived of their acid nature, and may become, or at leaſt materially concur to make up, a fixt alkali. For if ſea-ſalt, which chymiſts do not pretend to contain any ſuch alkali, be thoroughly diſſolved in a ſufficient quantity of ſpirit of nitre, and impregnated, this compounded ſalt will, as I have formerly noted, yield a conſiderable proportion of fixt alkali like that of ſalt-petre, which is as likely to proceed from the nitrous, as from the marine part of ihe reſulting ſalt; and if it do, it will make it the more probable, that it is not neceſſary, that the ſaline corpuſcles of ſpirit of nitre ſhould be primordial bodies, ſince they may be deſtroyed or turned into other ſalts; which is not leſs repugnant to the nature of a principle, than it is to be *de novo* producible from a body, that was not acid before.

SECT. IV.

IT may add much probability to what has been above diſcourſed, concerning the producibleneſs of the differing ſorts of ſpirits, if it ſhall appear, that the ſame body, meerly by different ways of ordering it, may be eaſily enough brought to afford, either acid, or inflammable, or volatile, commonly called urinous ſpirits, as the ſkilful artiſt pleaſes.

AN inſtance of this may be afforded us by ſome legumens, as peas, or beans; which if they be newly gathered and diſtilled in a retort, it will, I preſume, be eaſily granted, that they will, like many other green vegetables, afford, beſides a great deal of phlegm, an acid ſpirit; and if I much miſ-remember not, I had ſuch a ſpirit from either peas, or beans, or both, after they had been kept long enough to loſe their verdure. But if theſe ſeeds be at a fit time duely fermented with common water, I think it will not be doubted, but that they, as well as other mealy ſeeds, will yield an ardent ſpirit; but it will not ſo eaſily be ſuſpected, much leſs believed, that without adding any thing to them, or meddling with them, barely by keeping them in a dry place, for a certain number of months, they will yield a ſpirit, that by one, that did not know, whence it proceeded, would be judged near of kin to the ſpirit of urine, or of hartſhorn, and to other ſaline liquors drawn from animal ſubſtances. For having diſtilled theſe legumens by themſelves, without any additament, and without ſo much as breaking them, they afforded me ſpirits, not only far more like in ſmell to thoſe, I have compared them to, than they were either to acid, or vinous ſpirits, but very like them, in more intimate qualities; ſince they would, as the ſpirit of urine and hartſhorn, make a conflict with acid ſpirits, turn ſyrup of violets green, diſſolve copper blue, precipitate a ſolution of ſublimate into a white ſubſtance; and in a word, perform thoſe things, which I many years ago delivered in the tract about colours, and ſeveral ingenious writers have ſince embraced, as the diſtinguiſhing marks of volatile and urinous ſalts, or ſpirits. I ſay ſalts or ſpirits, becauſe I found that theſe drawn from vegetables, as well as thoſe afforded by animals, may eaſily by a dexterous ſublimation be brought to exhibit many of their nobler parts in the form of a dry ſalt, as well as in that of a ſpirituous liquor.

ANOTHER inſtance I ſhall take from the juice of grapes, though chymiſts will perhaps think it ſtrange, that I ſhould undertake to accommodate it to my preſent purpoſe; but there is no great myſtery in the buſineſs: for the freſh juice of grapes or muſt, though ſweet in taſte, will, if it be timely diſtilled to the conſiſtence

conſiſtence almoſt of a ſyrup, yield a copious phlegm, but not an ardent ſpirit: if the ſuperfluous moiſture be ſkilfully evaporated, there will remain a kind of rob or ſapa of a pleaſant tartneſs, which I have known uſed in ſome places, (as eſpecially in, or near *Switzerland*,) for an excellent ingredient of ſauces, and alſo, to be ſpread upon bread to be eaten inſtead of butter.

BUT if this raiſinee or ſapa were preſently diſtilled, I ſuppoſe it would yield no vinous, but an acid ſpirit: I ſaid, I ſuppoſe, becauſe for want of vineyards in *England*, I could not examine any liquor taken out of great veſſels of muſt, and therefore cannot ſay preciſely and experimentally, what diſtilled liquors it would afford; ſince I know not certainly, whether the great quantity of the ſweet liquor, and its continuance for ſome time (though not a long one) in the ſtate of what they call muſt, may not ſomewhat alter its productions, but if, as it is probable, that diverſity be not conſiderable, I may ſafely ſuppoſe, that the vinous ſpirit afforded by the juice of grapes, after fermentation has turned it into wine, is a produced thing, and was not in that form pre-exiſtent in the juice; for having purpoſely cauſed ripe grapes to be moderately preſſed, that their juice may, without much dreggy matter, be ſqueezed out, we put this liquor into a glaſs-head and body, and diſtilling it with a gentle fire, we obtained a ſcarce credible proportion of phlegm: and then transferring the ſomewhat inſpiſſated remainder into a retort, after having kept ſome of it (which had a grateful mixture of ſweetneſs and acidity) for raiſinee, we proſecuted the diſtillation with a ſtronger fire, and obtained not a vinous, but an acid ſpirit, as we found, not only by its ſmell and taſte, but by its corroding fragments of coral, even in the cold, by its growing ſweet upon minium, *&c.* Agreeably to which experiment, I found by trial, that raiſins, which conſiſt chiefly of the juice of grapes, inſpiſſated in the ſkins or huſks by the avolition of the ſuperfluous moiſture through their pores, being diſtilled in a retort, did not afford any vinous, but rather an acetous ſpirit, that, as an acid liquor, would work upon divers bodies, as ſpirit of vinegar would have done, and yet, as it was formerly noted, it is known, that raiſins being in a due proportion fermented with common water, will, after a certain time, afford a vinous and inebriating liquor; and though this time in the better ſort of the known ways, of making artificial wines, is wont to amount to many months, yet I have practiſed a way (which conſiſts chiefly in a determinate proportion of the water to the raiſins,) by the help of which, the liquor in very few weeks becomes fit to drink, and conſequently to afford by diſtillation a vinous ſpirit; but this only upon the by.

I SHALL now add, which probably you will think ſomewhat ſtrange, that from the juice of grapes even after it has been duely fermented, there may be obtained a diſtilled liquor, which having not found mentioned in authors, I thought, that I might take the liberty to name, and upon the account of its taſte, and ſome other qualities, to call it the acid ſpirit of wine: to ſatisfy you therefore, that there is ſuch a liquor, I will not make uſe of Rheniſh wine or other wines, that are thought to reliſh of acidity, but I will acquaint you with an experiment, that I choſe to make upon ſack, as a wine fully ripe, and more remote from an acid and tartarous nature, than thoſe are wont to be, that are made in leſs hot climates. We took then ſome good ſack, and having a digeſtive furnace, and in a glaſs-head and body ſlowly drawn off the ardent ſpirit firſt, and then the phlegm, (which even in this generous wine was copious) till there remained a liquor of the conſiſtence of a ſomewhat thin ſyrup, we removed it into a retort, and diſtilled it by degrees of fire, whereby we obtained, beſides a ſouriſh phlegm, that came firſt over, a true acid ſpirit, as appeared not only by the taſte, but by the hiſſing noiſe and numerous bubbles, that were produced, when we poured it upon a lixiviate ſalt; as alſo by this, that having put it upon poudered corals, it began briſkly to diſſolve them, even in the cold: we likewiſe made it corrode ſome metalline, and mineral bodies, of which it is not here neceſſary to give you an account, no more than of the black ſubſtance, that remained after the diſtillation: only two things I will here intimate about them: The one, that as this acid ſpirit of wine has its origination differing from that of other known acid ſpirits, and even from ſpirit of vinegar, ſo I thought it not irrational to conjecture, that it might have ſome peculiar qualities, whoſe diſcovery I leave you (if you think it worth the while) to proſecute: only by way of encouragement, as well as hint, I ſhall tell you, that having put ſome of it, for a certain reaſon, upon filings of copper, in ſuch manner, that ſome of them, after being wetted with the ſpirit, ſhould remain expoſed to the air, and others lie beneath the liquor, I found, though the trials were made in the cold, that in a day or two the expoſed filings had gained a fine blueiſh-green colour, but the ſpirit, that ſwam upon the other filings, did in few hours acquire a fine redneſs, which afterwards in two or three days degenerated into a colour like that of the expoſed filings. The other thing I will note, relates to the *caput mortuum* of the diſtilled wine, which I found a more fixt body than one would have expected, and it is, that though probably the finer part belonging as to other vegetable mixts, ſo to the juice of grapes, being attenuated and ſubtilized, was changed into an ardent ſpirit, and therefore appeared not in the diſtillation, in the form of oil, yet it is not unlikely, that the coarſer part of the oleaginous ſubſtance remained ſtill in the *caput mortuum*: for holding it in the flame of a candle, I obſerved, that it would partly exhale in thick ſmoke, partly melt, and as it were fry, and partly burn with an actual flame, which was not only continued, while the flame of the candle cheriſhed it, but would after it was re-

moved from the candle, continue a pretty while to flame upon its own account, and a parcel of it being caſt upon quick (but not upon flaming) coals, burned with a blaze, almoſt as if it had been amber, or bitumen. I could here tell you of fine cryſtals of wine, that I many years ſince made by a peculiar way, of the above mentioned extract of ſack; but this may be elſewhere more fitly mentioned.

To return therefore to our juice of grapes, we ſee, that meerly by a ſeemingly ſlight difference in the management of it, it may be made to afford either a vinous, or acid ſpirit; and I ſhall now add, that it may alſo be brought to yield a volatile or urinous one; for it is known, that in proceſs of time, wine affords tartar; and though chymiſts ſuppoſe the ſpirit of tartar to be of a quite differing nature from that of urine and of ſoot, and though I have elſewhere ſhewn, that tartar diſtilled the common way affords a double ſpirit, namely, an acid, and another, that I thought fit to call anonymous; yet I elſewhere ſhow, that by a peculiar and ſlow way of operating, I have been able to obtain (though perhaps not conſtantly) from crude tartar, without any additament, a ſpirituous ſubſtance, that in taſte, ſmell, and divers manifeſt operations, much more reſembled the volatile ſpirit of urine, or rather that of ſoot, obtained as mine of tartar was, by meer diſtillation, than an acid ſpirit: with which (ſo little did they agree) it was diſpoſed to make a conflict as ſoon as they were put together. But ſuch a kind of volatile ſubſtance may be far more eaſily obtained from the lees of wine, than from tartar; for having been accidentally informed, that an expert chymiſt in *Germany* had found the way to get ſtore of volatile ſalt from lees of wine, I reſolved to try, whether it might not be done without any addition; and having procured ſome of the beſt lees (I could get) of Rheniſh wine, I cauſed them to be expoſed in broad veſſels to the ſun, and the free air, (which circumſtance yet I am not ſure is neceſſary) that they might leiſurely be dried, if not alſo be impregnated, in order to the volatility of their ſaline parts. Then theſe dried fæces being carefully diſtilled in a retort by degrees of fire, the liquor was ſlowly rectified, by which means there aſcended before the phlegm a ſpirituous part, which would turn ſyrup of violets green, precipitate diſſolved ſublimate into a white powder, ſoon colour itſelf upon copper with a deep blue, and in ſhort do ſeveral things, by the performance of which we have elſewhere diſtinguiſhed volatile ſalts and ſpirits from acid and from vinous ones. By all ſuch trials upon the juice of grapes, we may infer the truth, we intended to prove by them, namely, that the ſame matter, as it is differingly managed, may be made to afford an acid (beſides one, that is truly acetous) a vinous, and a volatile ſpirit: beſides that, *ex abundanti*, it may alſo be made to yield, as I have noted in mentioning the diſtillation of tartar, another ſort of ſpirituous ſubſtance, as yet anonymous.

New obſervations about the adiaphorous ſpirits of Woods and divers other bodies.

AND now having fallen upon the mentioning of this ſort of ſpirits, that I have called anonymous, ſince I remember not that the notice I gave the publick of them * has engaged any writer to examine them; I am content on this occaſion to touch upon ſome of the more quick and eaſy trials, that I have made about this kind of liquors, that I may both excite and ſomewhat aſſiſt the curioſity of thoſe enquirers, that ſhall attempt to make a farther diſcovery of the nature of theſe ſpirits; which when I firſt ſeparated from the acid ſpirits, wherewith chymiſts had before confounded them, as ſtyling them, and taking them to be meerly the acid ſpirits of tartar, wood, *&c.* their properties were ſo little known to me, that I contented myſelf to ſtyle them anonymous ſpirits: but ſince having found them to differ in divers qualities, both from vinous, from acid, and from urinous ones, and having not ſufficiently diſcovered their poſitive properties, I was wont to give them a negative appellation, and call each of them the neutral or adiaphorous ſpirit of the body, that affords it, (whether it be tartar, wood, or any other like concrete.)

BUT before I deſcend to particulars, it will not be improper to premiſe in general three or four things not unfit to make way for the obſervations, that are to follow them.

1. I KNOW not, whether it will be requiſite to repeat in the firſt place, that our adiaphorous ſpirit may be obtained by diſtilling the liquor, that is afforded by woods and divers other bodies; by diſtilling this liquor, I ſay, from corals, or calcined lead; for by this means the acid corpuſcles of the menſtruum will work upon the coral or the lead, and ſo faſten themſelves to what they corrode, that they will eaſily enough part with the adiaphorous ſpirits, which by this means are permitted to aſcend by themſelves and fall into the receiver, in the form of a liquor. This, as I was ſaying, I know not, whether it be neceſſary to inſiſt on in this place, becauſe I have already mentioned it in another paper: but I think it may be very pertinent to relate here, that I endeavoured to try, whether there was not a difference in gravity or fixedneſs between the acid and neutral ſpirit of wood, without mortifying the firſt; and whether by the help of this gravity and fixedneſs, I might not be able to ſeparate, at leaſt in great part, the acid from the other, and ſo preſerve it in its diſtinct nature.

IN order to this, I cauſed a pretty quantity of the rectified ſpirit of box to be ſlowly diſtilled in a glaſs body and head, placed in a ſand cupel with the flame of a lamp, as that, which would give a more gentle and regular heat than charcoal; as indeed in the firſt twenty-four hours or thereabouts, this furnace afforded but about two ſpoonfuls of liquor; and though the menſtruum firſt put in ſcarce exceeded, by our gueſs, one pint or pound (if it were ſo much) yet it was divers days and nights in drawing over.

* This was done in the *Sceptical Chymiſt*.

over. And in this operation the moſt obſervable circumſtances were theſe two: Firſt, that the liquor, that firſt aſcended, was not phlegm, but had a very penetrant taſte, yet without any manifeſt acidity, diſcoverable by the tongue, though by putting it upon fine powder of coral (whether crude or calcined I remember not) it had ſome operation, that made me think it not altogether devoid of acid particles. Secondly, having often ſhifted the receiver, the better to judge, whether the portions of the aſcending ſpirit were conſiderably different in quantity, I found that, towards the latter end, the liquor, that came over, was ſharper than before; and having, at length, diſtilled all I could make to ariſe, we found the laſt parcel of liquor (which was copious enough) to be of a good yellow colour (though thoſe that preceded it were limpid enough) and both to ſmell ſtrong of vinegar, and to taſte more acid upon the tongue than ſpirit of common vinegar itſelf: ſo that if I had not known, how it was obtained, I had ſuſpected it to be what the chymiſts call *acetum radicatum*; and accordingly I found it to be a very active menſtruum in the diſſolution of ſome bodies, that, for trial-ſake, were put into it. All which ſeems to argue, that the acid portion of ſuch diſtilled liquors, as I have been ſpeaking of, is more ponderous, or more fixt, than the adiaphorous ſpirit, which, upon this account, may be in great part ſeparated from it by bare diſtillation, if it be warily enough made.

My ſecond general remark ſhall be, that I have obſerved theſe neutral ſpirits to be not all of them, in all things, of the ſame nature; ſince though they agree in ſome general attributes, which ſuffice to entitle them to the ſame ſpecies or denomination, yet they ſometimes differ from one another in particular qualities: which advertiſement I thought it neceſſary to premiſe, that it may not ſeem ſtrange, and that I may not be blamed, though ſome of the trials I ſhall ſet down do not punctually ſucceed in their hands, that ſhall not make uſe of the anonymous ſpirit of box, which I employed; not becauſe I think it better than any other, but becauſe amongſt divers, that I have made uſe of, I had then a greater quantity of it at hand. But though for this reaſon, when I ſhall ſpeak what I have obſerved in an adiaphorous ſpirit, without naming it, I would be underſtood of the ſpirit of box, which I had freed from its acid mixture by diſtilling it from calcined coral; yet I ſhall not ſo confine my ſelf to this, as not to mention, now and then, ſome other ſpirit of the ſame family.

The third general obſervation, that I ſhall make about our adiaphorous ſpirits, is, that though the few chymiſts, that have taken any notice of the diſtilled liquors, for example, of woods, were wont, by reaſon of their acid taſtes to look upon them, as of a meerly acetous nature, and having accordingly called them the vinegars or acetous ſpirits of wood, yet really the acid portion of theſe diſtilled liquors is far from being the greateſt: for beſides what other trials I have purpoſely made, I remember I took eight ounces of the rectified ſpirit of box, wherein the acetous and neutral ſpirit remained confounded, as they had been in the firſt diſtillation; and having poured this upon a quantity of of calcined coral, ſufficient to ſatiate the acid corpuſcles, (which quickly fell to corrode it with noiſe and bubbles) we gently diſtilled it to a dryneſs in a glaſs head and body, by which means we obtained of adiaphorous ſpirit but eight grains leſs than ſeven ounces and an half, and ſome of the menſtruum having been waſted in the operation, the acid corpuſcles remaining in the bottom, with the coral they had corroded, weighed but between two and three drachms; which ſhews, that notwithſtanding the not contemptible quantity of ſtrong ſpirit of vinegar, that by our lately recited obſervation the diſtilled liquors of box does contain, the corpuſcles, that make it ſo acid, being concentred, take up but a little room. And ſince it was rational to ſuſpect, that the acetous corpuſcles being made without fermentation, might have ſomething peculiar in their nature, I cauſed them to be gradually diſtilled with a ſtrong fire from the coral, and thereby obtained a very red ſpirit, of which, though many chymiſts would take it for a volatile tincture of coral, I ſhall only obſerve, that its ſmell was very ſtrong, and its taſte exceeding penetrant, but very differing from that of acid liquors.

Whether our adiaphorous ſpirit may (as I ſometimes ſuſpected it may) be generated, by a commixture of the finer parts of the oil of the wood reduced to an extraordinary ſmallneſs, and thereby capable of being exquiſitely mixt with the phlegm, and ſtrictly aſſociated with its particles, I ſhall ſtay, till I be better furniſhed with experiments, before I venture to determine.

Having premiſed the foregoing general obſervations, I ſhall proceed to particular ones, as ſoon as I ſhall have advertiſed you, that for the better diſcerning the phænomena to be produced, I choſe to make almoſt all the following trials in cylindrical glaſſes of about an inch in diameter.

To the phænomenon I am about to take notice of, I therefore give the firſt place, amongſt thoſe produced by the help of our adiaphorous ſpirit, becauſe it is uncommon, and not unpleaſant: for though we have many experiments of the ſudden tranſmutation of colours, whereby we change one into another; yet we have very few of the production of colours *de novo*, in bodies, that were colourleſs before. And I remember not, that the writers I have ſince met with, have added any experiments of this kind to thoſe three or four, that I have mentioned in the hiſtory of colours.

1. I Shall begin then with obſerving, that having into our adiaphorous ſpirit of box dropt a convenient quantity of ſtrong and tranſparent oil of vitriol, and ſhaking the liquor together, there preſently emerged a rich and lovely red colour; which at firſt was diaphanous, but afterwards grew ſo deep, that it was opacous, though by ſhaking the glaſs, the thin liquor, that would ſlowly glide down the inſide of the glaſs, being held againſt the light, manifeſted,

that

that the colour was ſtill red, though much more dark and muſcadine-like than before.

2. SOME common aqua fortis being put to our neutral ſpirit, and ſhaken a little with it, preſently gave it a rich amber or high yellow colour, but not a true red: but if the liquors were not mingled by agitation, the ſpirit did but ſlowly and gradually obtain the above mentioned colour, which was ſomewhat deeper than that of ſack: after this change the liquor continued tranſparent, and (which is a circumſtance not to be omitted) the change at firſt was wrought without any manifeſt precipitation, though afterwards, when the mixture had reſted a good while, there appeared ſome little and light fæculency at the bottom of the glaſs, and the inſide of it, as far as the liquor reached, was ſullied with a cloudineſs not eaſy to be waſhed off. One circumſtance more of this trial I muſt not omit, which is, that notwithſtanding the ſtrong and offenſive ſmell, that is wont to be juſtly complained of in aqua fortis, in our mixture it was either none, or but very faint, being concealed (if I may ſo ſpeak) or ſuppreſſed, and partly perhaps diſguiſed by the predominant odour of the adiaphorous ſpirit.

3. SOME ſpirit of ſalt being mingled with our ſpirit of box, the mixture became much leſs diaphanous than the liquors had been before their conjunction, and for a day or two was only whitiſh; but when we removed it into a digeſtive furnace, and kept it there for many hours, it acquired a colour high enough, partaking of brown and yellow, and appeared to have let fall ſome little ſediment to the bottom of the glaſs.

4. HAVING put ſome of our adiaphorous liquor on ſalt of tartar, it had not any ſenſible operation on it that we took notice of, ſave that it diſſolved the ſalt; and, after ſome digeſtion, appeared of a yellow colour tending to brown, and faſtened to the inſide of the phial in many little grains of ſalt, that ſeemed to have been firſt diſſolved, and then coagulated again in newly-emergent figures.

5. OUR adiaphorous liquor being confounded with high rectified ſpirit of wine, neither of them appeared to change colour much (for ſome change there was towards yellowneſs) or be opacated by their conjunction, even after ſome days digeſting; but the vinous ſpirit did not hinder the other from being turned red by the action of ſome potent acid, when it was poured on the mixture.

6. RECTIFIED ſpirit of urine being put to our adiaphorous liquor did not make any conflict with it, but joined with it quietly, as the above mentioned ſpirits had done, and did not manifeſtly change the colour of either of the liquors, whilſt they were kept many hours in the cold; but being transferred into a digeſtive furnace, and kept there a night or two, the liquor acquired a high colour, which was almoſt orange-brown, and there appeared ſome little fæces at the bottom. Having made theſe trials upon our ſpirit with ſimple liquors, I thought fit to make ſome with ſuch compounded liquors, as the ſolution of metals are, to ſee if our ſpirit, though neither manifeſtly of an acid, or an urinous, or a lixiviate nature, would procure precipitations of any part of the diſſolved metals.

7. IN proſecuting this enquiry, I dropt into ſome of our ſpirit a little ſolution of refined gold, which at firſt imparted thereto its own colour, (perhaps ſomewhat heightened) but the mixture quickly loſt its tranſparency and grew muddy, and, after a while, let fall a conſiderable quantity of ſediment or precipitate, the ſupernatant liquor having acquired a browniſh colour.

8. HAVING mixt our ſpirit with a good ſolution of crude lead, made with an appropriated menſtruum, that diſſolves it readily and clear, almoſt as aqua fortis does common ſilver, the mixture preſently grew muddy, and at length, after ſome days, let fall a copious ſediment, over which ſwam a liquor between brown and red.

9. WE put to our ſpirit of box ſome fine ceruleous tincture or ſolution of copper, made with an urinous ſpirit, (as of putrified urine, or ſal armoniac,) and ſoon perceived the mixture to grow troubled, which afforded us, though but very ſlowly, a copious reſidence.

10. WE mingled with our ſpirit a convenient quantity of ſtrong infuſion of ſublimate made in fair water, but found not any manifeſt re-action betwen thoſe liquors, no more than we did between dry and undiſſolved ſublimate and the ſame ſpirit, when we kept them together in this ſame phial.

11. MIXING our ſpirit with oil of tartar *per deliquium*, there did not ſuddenly appear any manifeſt change; but having digeſted the mixture for ſeveral days, there precipitated a light fæculency; and the ſupernatant liquor, which was tranſparent, appeared of a colour inclinable to red.

12. WE alſo mingled with ſome of our ſpirit a convenient quantity of vitriol of copper diſſolved in fair water, till the liquor ſeemed ſatiated with the vitriol; but I remember not that in ſome days, but the ſolution grew manifeſtly opacous or diſcoloured.

13. WE put to our ſpirit a ſolution of tin, made in a menſtruum, that diſſolves it clear, and found very little alteration to enſue, though we left the liquors many hours together.

14. BUT when I put to our ſpirit a convenient quantity of the ſolution of mercury, made in aqua fortis, the colour of the mixture became firſt deeply yellow, and in a minute or two intenſely red; and being digeſted for ſome days, I found at the bottom of the phial a white precipitate, much more copious than I expected, and the tranſparent liquor, that ſwam above it, was of a rich golden colour. Whether phyſicians or ſurgeons ſhould think fit to employ this precipitate, or this tinged liquor for medicinal purpoſes, I ſhall leave them to conſider.

15. SEVERAL of the foregoing experiments were tried with the ſpirits of other woods than box, and in particular with thoſe of oak and guaiacum, the phænomena of which experiments were not always the ſame with thoſe above

above recited, which may probably argue ſome difference in the nature of ſuch ſpirits, as well as there is in the conſtitution of the woods, that afforded them; nor for certain reaſons have I thought fit to recount here all the trials I have made with the adiaphorous ſpirit of box it ſelf, of which ſort I ſhall for example-ſake name only two, which I remember as having been the lateſt I made; whereof the firſt was, that having put ſome of our neutral ſpirit upon ſome pieces of fine red coral, and kept them there many days, the liquor did not appear to have extracted any tincture from them, though the upper part of the higheſt fragments ſeemed to be turned white. And the other was, that having taken a parcel of ſpirit, that came over by rectification in a lamp furnace, long before the more fixt acetous ſpirit came to aſcend, and having purpoſely expoſed a phial ſcarce half full of it, in a very ſharp froſty night, in a garden covered with ſnow and ice, it was taken up the next morning, not at all frozen, but leſs limpid than before, and this little opacity did (ſomewhat to our wonder) remain more or leſs for ſome weaks after.

ABOUT THE

PRODUCIBLENESS OF SULPHURS.

PART III.

THOSE ſubſtances, that chymiſts are wont to call the ſulphurs of the mixt bodies, that, by the help of the fire, are brought to afford them, are not of ſo uniform a nature, as might be expected in the portions of the ſame principle. For as, on the one ſide, chymiſts make inflammability to be the conſtituent character of ſulphur, ſo on the other ſide, it is obvious enough to thoſe, that are any thing verſed in ſpagyrical operations, that there are at leaſt three ſubſtances manifeſtly differing in conſiſtence, texture, or both, that, according to the notion lately aſſigned, ought to be referred to ſulphur. For ſometimes the inflammable ſubſtance, that is obtained from a mixt body, by the intervention of the fire, appears in the form of an oil, that will not mingle with water; ſometimes in the form of an ardent ſpirit, that will readily unite with that liquor; and ſometimes alſo in the form of a conſiſtent body, almoſt like common ſulphur.

NOTWITHSTANDING theſe various forms, in which it appears, it is not impoſſible, but that in many mixt bodies, not to ſay in all, what is called ſulphur may be no primordial ingredient, but rather a generated or reſulting thing. For that, which is common to theſe differing bodies, that paſs under the name of ſulphurs, and which is the conſtituent quality (if I may ſo call it) that diſcriminates them from the other material principles of mixt bodies, muſt be confeſſed, if we will ſpeak intelligibly, to be inflammability, or, if you pleaſe a diſpoſition to be turned into fire, and uſually alſo into flame. Which being being premiſtd I conſider here, that ſulphur it ſelf is made of the ſame univerſal matter, whereof other bodies conſiſt, and is but a coalition of certain particles thereof, whoſe aggregate, by having ſuch a contexture, motion, *&c.* acquires thoſe properties, for which a body is called ſulphur. And therefore if the like contexture happen to be found in other portions of matter, or (to expreſs my ſelf more fully) if art, or chance can frame and bring together particles of matter, and give them ſuch a contexture as is apt and ſufficient to diſpoſe them to be kindled and flame or burn away; theſe qualifications of ſuch an aggregate of corpuſcles will ſuffice to confer on it the nature of a ſulphur, whether this portion of matter do, or do not conſiſt, or copiouſly participate, of the chymiſts primeval ſulphur. For it is not by virtue of the long preceding duration of a thing, but by that of the eſſential qualities belonging to it, that a body deſerves this or that denomination. As the ſnow, that fell yeſterday, and was generated in a trice, is as true ſnow, as that, which has lain, perhaps for many years, on thoſe *Alps*, that are always covered with ſnow, or on the higheſt mountains of the frigid zone. And in the judgment of the chymiſts themſelves, a pound of quickſilver recently tranſmuted by a grain or two of their elixir into gold becomes as true gold, as that, which was coeval with the mountains, where nature has formed the ancienteſt mines of that metal.

SECT. I.

Of the production of oils.

THAT it is not neceſſary, the oils, or ſulphurs obtained by the fire from mixt bodies, ſhould be a primeval element or principle, may be probably argued from the experiment mentioned in the *Sceptical Chymiſt* about the growth of plants nouriſhed by meer water, which nevertheleſs, by diſtillation, afforded an oil. And we ſee, that in almond trees, walnut trees, and divers others, the rain water, that inſinuates it ſelf into their roots, is, by ſucceſſive changes of texture, reduced into the oil, which the fruit by expreſſion ſo plentifully affords. And to confirm our experiment from the growth of plants by tranſmuted or aſſimilated water, to obviate the ſuſpicion of common water's being im-

nated with the groſſer juices of the earth, I employed diſtilled water. About which experiment I find this ſhort memorial among my *adverſaria*.

[A SPRIG of mint put into rain-water diſtilled, and fed almoſt wholly with rediſtilled rain-water, weighed *July* 15. gr. 3. and was taken out *Auguſt* the 14th, and being well dryed with paper and a cloth, weighed 10 grains and about a quarter: ſo that within leſs than a month it grew to be three times as heavy, as when it was firſt put in. Another put in, and taken out at the ſame time with the former, had attained within leſs than a month to near four times its firſt weight, and had ſhot out a ſecond ſprig much higher than the firſt, and ſtore of roots, ſome of them near as long again as the whole plant, when it was firſt put in.]

IF we conſider, what a great quantity of oil is afforded by an olive-yard, whoſe trees are probably, as well as thoſe that bear apples, cherries, and other kinds of aqueous fruits, nouriſhed chiefly by rain-water, that being imbibed by the roots is by various digeſtions, or preparatory changes, turned into oil in the olive, it will not appear unlikely, that oil may be produced of other ſubſtances; ſince in our inſtance it ſeems to have been made by tranſmutation of water, though this be generally reputed to be of all liquors the moſt contrary to it, and is evidently of a nature exceeding diſtant from it.

AND here I ſhall relate an experiment, by which I attempted to produce it, out of only two diſtilled liquors, that according to the common eſtimation of chymiſts are uncompounded bodies; and, whether they be really ſo or not, are each of them readily diſſolvable in water, and in one another. Take then of oil of vitriol, and of ſuch ſpirit of wine, as is totally inflammable, an equal weight; mix them together by degrees, leſt the heat they will produce ſhould breed ſome inconvenience, and having digeſted them a good while (which yet is not abſolutely neceſſary) with a very wary management of the fire (for elſe the experiment will eaſily miſcarry) draw off what will come over; and if you go to work, as I have ſeveral times done, you ſhall obtain, beſides a ſubtile and odoriferous ſpirit of wine and an acid ſulphureous liquor, a conſiderable quantity of chymical oil, which I have had ſometimes deeply coloured, ſometimes clear like fair water: and this oil you will perchance look on as an odd liquor, when I tell you, that I have had it, ſometimes exceeding fragrant, and (though the oil of vitriol be ſo highly corroſive) without any acidity at all, the taſte of it being very ſubtile and penetrant, but no way like that of any ſaline liquor, that we know. This hath ſometimes inticed me to doubt, whether it hath been made of the ſpirit of wine, or of the oil of vitriol. The circumſtances laſt mentioned ſeem to perſuade the former; eſpecially if I add to them, that I found by trial purpoſely made, that this oil would readily mix with good ſpirit of wine, that had never had to do with oil of vitriol; but on the other ſide it ſeemed conſiderable, that the oil of vitriol by this operation was much weakened and changed, and it appeared not, whence the ſpirit of wine ſhould have ſo great a fragrancy; which conſiderations were backed by this more weighty argument, that this oil was ſo ponderous, as to ſink not only in common water, which is yet a far more heavy liquor than pure ſpirit of wine, but in the acid ſpirit itſelf, which ſeemed to be the remains of the altered oil of vitriol, which, by reaſon of its abounding in ſalt, you will eaſily grant to be far heavier than common water. But I need not much trouble my ſelf, to determine, which it is of the two liquors, that affords this ſtrong oil; for it may well be (though not equally) compoſed of both, by their mutual action, and the operation of the fire, united in the form of oil. And if it be objected, as probably it will, that this inflammable ſubſtance is made but by extrication of the parts, that lay concealed in the liquors before they were brought together, it may be anſwered, that this ſhould not be ſuppoſed, but proved; which till it be, our cauſe will be favoured by our experiment, wherein there appears nothing ſo likely as a change of texture; to which may be aſcribed the production of our anomalous chymical oil, ſince this plainly ſeems to reſult from two bodies, whereof neither was a true oil before. For each of them would readily mingle with water, whereas this produced oil of ours, being ſhaken with water, would break, like common oils, into numerous little globules; which would preſently after ſink to the bottom, and re-unite there into a liquor, which for trial-ſake I have kept divers weeks in the water, and found it at laſt undiſſolved by it. Some odd properties of this oil make it ſeem likely to participate of ſome of the nobler parts of vitriol, and the ſulphur of that metal having extraordinary virtues aſcribed to it, by ſome of the famouſeſt and intelligenteſt Spagyriſts, (as *Baſilius Valentius*, *Helmont*, &c.) I kept ſome quantity of this oil by me for ſeveral years, to obſerve, as I did with pleaſure, the alterations, that time would produce in it, and afterwards I imparted either ſome of the medicine itſelf, (whereof the firſt trial proved very ſucceſsful) or the ways of preparing it, or both, to ſome ingenious men, who (I am told) did not all of them remember me in the free mention they made of it.

BUT this concerns not our argument, upon occaſion whereof I ſhall obſerve upon the by, that though chymiſts ſhould be able to prove, that our oil was but ſeparated from the ſpirit of wine, or the oil of vitriol, in which it was latent before, yet ſtill the experiment would afford me a conſiderable reaſon for queſtioning a main point in the doctrine of the vulgar chymiſts, who confidently pretend to prove from the number of ſimilar ſubſtances (as they ſuppoſe them) obtained from a mixt body, that it was actually compounded of juſt ſo many diſtinct and true material principles, and ſuch a quantity of each. For if from a diſtilled liquor, as the oil or rather ponderous and acid ſpirit of vitriol, or from alcohol of wine, which is commonly reputed to be uncompounded, a liquor of quite another

another kind may be (not made but) ſeparated, how little reaſon have we, to take it for granted with the chymiſts, that every diſtilled liquor, that they look upon as one of the component principles of the body, that afforded it, is a homogeneous ſubſtance not further diviſible into differing parts?

SECT. II.

Of the production of inflammable ſpirits.

AFTER what has been hitherto delivered concerning the production of oils, I ſhould now proceed to that of another ſort of liquors, referred by the chymiſts to the principle they call ſulphur; though better known to others by the name of inflammable ſpirits. But of theſe I ſhall purpoſely forbear to diſcourſe in this place, and rather refer to what I have ſaid to them in another, where I thought it more proper to conſider them; namely, in one of the ſections of that part of theſe notes, that treats of the producibleneſs of vinous ſpirits.

SECT. III.

Of the production of conſiſtent ſulphur.

IF you ſhould here tell me, as perhaps you will do, that what I have been hitherto ſaying relates but to inflammable liquors, whereas ſulphur, in its moſt proper and primary acception, ſignifies a mineral body; I ſhall anſwer, that, as I formerly intimated, the chymiſts uſe the term ſulphur ſo ambiguouſly, and ſo uncertainly, that they have made it difficult for other men's diſcourſes to avoid all appearance of participating of the confuſedneſs, they ſeem to have affected in theirs. But becauſe the moſt intelligible, and leaſt indefinite notion their writings ſuggeſt of ſulphur, is, that it is a combuſtible and inflammable principle; I have hitherto treated of it as ſuch. And as for that ſulphur, that is commonly known by that name, and bought in ſhops, though I know there are ſome chymiſts, that have affirmed, that from vegetables and animals they can ſeparate ſuch a ſulphur; yet ſince they are not wont to teach us the way of doing it, nor give us any proofs, beſides their own word, of their having ever done it themſelves, the thing has ſeemed ſo improbable, that I find few or none of the more judicious of their own party, that look upon it, as other than a brag: only a follower of *Glauber* I find to have undertaken, by his maſter's directions, to produce a real ſulphur, like the mineral, out of vegetable charcoal, by a way, which, becauſe it has deceived more than him, and is ſpecious enough to impoſe upon thoſe, that either are not chymiſts, or, if they be chymiſts, are not cautious men, I ſhall here ſet down, and examine, as after the author I made it.

WE took then equal quantities (ſuppoſe a pound of each) of good oil of vitriol and of common ſea-ſalt, diſſolved in as much water as was requiſite: this mixture was ſlowly diſtilled, till the bottom was throughly dry, (which it will not be ſo ſoon as it begins to look white, or appear coagulated;) then ſetting aſide the liquor, (whereof the firſt part that came over was phlegm, and the other part ſpirit of ſalt) we took out the *caput mortuum*, (which, if one pleaſes, may be purified by being diſſolved and philtered) and having beat it to powder with about one fourth or one eighth part of its weight of charcoal, we put it in a ſtong crucible, and kept the mixture melted in a vehement fire, till it grew of a dark reddiſh colour, for by that time ſuch a change was made in the maſs, that it both ſmelt and taſted rankly enough of ſulphur; and if ſpirit of ſal armoniac were ſeaſonably diſtilled from it, with a competent, but not over-haſty fire, the aſcending ſpirit would be manifeſtly impregnated with ſulphur not difficultly ſeparable, which may alſo be divers other ways obtained from the ſame fixt *caput mortuum*,

BUT for all this ſpecious operation, I do not take the ſulphur, thus produced, to have been the vegetable ſulphur of charcoal, but a mineral ſulphur, that lay concealed in a liquid form among the ſaline parts of the oil of vitriol.

FOR, firſt, it is not likely, that ſo ſmall a quantity of charcoal, as was employed in this experiment, and much leſs that ſo ſmall a quantity, as may ſuffice to make it, could contain ſo much ſulphur, as may this way be obtained.

NEXT, that common vitriol is not deſtitute of mineral ſulphur, may be eaſily conjectured by the ſulphureouſneſs of the marchaſites, whereof it is wont to be made. In ſo much that in divers countries, as about *Liege*, and in ſome parts of *Italy*, from the ſame ſubſtance, that affords them vitriol, they obtain by ſublimation great quantities of common ſulphur, which is ſold for ſuch into divers other countries. And I have found by trial, and do not at all think my ſelf in that ſingular, that one may obtain from vitriol an oil, and a *caput mortuum*, which being put together, afforded a ſmell of common ſulphur ſo ſtrong, that I was ſcarce able to indure it.

AND to come yet more cloſe to our experiment, I have (as I have elſewhere mentioned) purpoſely tried, more than once or twice, that by diſtilling together common oil of turpentine and common oil of vitriol, the former of thoſe liquors would make a ſeparation of ſome of the ſulphur, that lay concealed in the latter, and as it were extricate and extract it: ſo that beſides an exceedingly ſulphureous liquor, which ſometimes was made white by the copiouſly diſſolved (and partly precipitated) ſulphur, that paſſed into the receiver, we had in the neck of the retort a yellowiſh conſiſtent body, which being put upon a quick coal, would, after a little yellow flame (probably proceeding from ſome adhering parts of turpentine) afford good ſtore of blueiſh flame, like that of common ſulphur, which it alſo emulated in its ſmell. And ſuch a kind of ſulphur I have alſo ſeen, in tract of time, ſettle itſelf, in no inconſiderable quantity, at the bottom of the liquor, diſtilled from the mixture of the two above mentioned oils. Nor are theſe the only ways, by which I have obtained from oil of vitriol manifeſt

proofs of its containing a mineral ſulphur very like to common ſulphur.

AND in particular it now comes into my mind, that I once put into a retort, together with one part of running mercury, four parts of oil of vitriol, and having diſtilled off the menſtruum, by degrees of fire, there remained at the bottom of the glaſs a very white powder. This calx, being afterwards gradually preſt with a ſtronger fire, afforded in the upper part of the retort a great many ſmall bodies, that looked like half beads of amber, and ſeemed to be of very fine ſulphur, (but were afterwards confounded with many other aſcending corpuſcles.) This amber-like body (which was ſomewhat copious, and, as to ſome portions of it, whitiſh) by its readineſs to be melted, by its ſmell, and by the blueiſh flame it afforded, when it burned, appeared to be a kind of ſulphur, which you will eaſily grant to be far more unlikely to have proceeded from ſo homogeneous a body, as the quickſilver, than from the oil of vitriol, which we have already ſhewn to conſiſt of divers ſulphureous as well as many acid corpuſcles. And on this occaſion I remember, that, whereas upon mingling the oils of turpentine and of vitriol in a due proportion, I have conſtantly obſerved, that they incorporated into a mixture, that was deeply red, (and this may eaſily be tried by letting fall two or three drops of oil of vitriol upon ſome drops of that of turpentine, and mixing them in a concave veſſel, or even in a hollowed piece of paper) whereas, I ſay, I obſerved this, I was thereby induced to ſuſpect the chymical (for I ſay not, the optical) cauſe of that phænomenon might be, that the terebinthinate oil had made a ſolution of divers ſulphureous particles it met with in the oil of vitriol, and by that means acquired ſuch a redneſs, as we ſee that common flower of ſulphur gives to the oil of turpentine, when it is diſſolved in it. And to examine this conjecture, I found, that divers other chymical oils, and oil of aniſeeds it ſelf, as remote as it is from redneſs, would preſently acquire that colour, being carefully incorporated with a due quantity of oil of vitriol. But this conjecture is propoſed only upon the by.

AS for the ſulphur of minerals and metals, I confeſs, I have not yet found enough, either in chymiſts books, or in my own experience, to make me willing to ſpeak dogmatically about them. And this the rather, becauſe firſt, as to the ſulphurs, that are ſometimes obtainable from ſome of the minerals, I think it may be doubted, whether they belonged to thoſe minerals as eſſential ingredients, or were only corpuſcles of common ſulphur, perhaps a little altered, that were mingled in the bowels of the earth, with other parts, that are eſſential to the nature of the mineral. As we ſee, that in native cinnabar the mercury, which, according to chymiſts, is a complete metal by it ſelf, is ſo mixt with another body, as not to be diſtinctly diſcernible, till it be ſeparated by the fire. And this cinnabar affords me an inſtance, the more fit for my preſent purpoſe, becauſe I have ſometimes by an eaſy way obtained a ſulphur alſo from it: and ſince we have lately noted, that the vitriolate marchaſites afford great ſtore of common ſulphur, by a groſs way of ſeparation, it ſhould not ſeem irrational to ſuſpect, that ſome common ſulphur may remain more cloſely mixt with the ſaline and metalline parts of the vitriol afforded by the ſame marchaſites; from which latent corpuſcles of ſulphur may in part proceed the ſulphureous ſmell, and other like things, that we have lately taken notice of in vitriol, and its oil. And perhaps by the ſame conſideration one may account for the ſulphureous qualities; that are ſometimes to be met with in the liquors, that paſs for the vinegars of mineral bodies, and particularly antimony; to which may now and then be added ſome metalline ores: ſince, I remember, I have had ſuch a ſulphureous liquor from good lead-ore, that I had ordered to be purpoſely digged out of the mine at *Minedeep*, and being put in cloſe veſſels ſpeedily conveyed to me. And that nature her ſelf may blend an imperfect mineral with lead, I have had occaſion to obſerve by an ore, whereof the owner found a mine, but not being able to diſcover what it was, deſired me to inform him. For this gave me occaſion to conſider the ore (whereof I have yet a lump by me) and to obſerve, that it was ſo differing from the other ores of that country, that I did but diffidently gueſs, that it was a mixture, that nature had made of lead and antimony, till particular trials had juſtified my ſuſpicions.

BUT this is not all I had to ſay about the ſulphurs of foſſils: for though I know, that chymiſts pretend to teach us ways of extracting the true ſulphurs of minerals and metals; and experience aſſures me, that a real combuſtible ſulphur may be in a pretty quantity obtained from antimony; yet there are two ſcruples, that ſuffer me not fully to acquieſce in what they teach. The firſt is this, that chymiſts oftentimes deceive others and themſelves too, by miſtaking thoſe things for the true ſulphurs of minerals and metals, that really are not ſo: of which I ſhall give a plain inſtance in the preparation, that many Spagyriſts deliver of the ſulphur of antimony.

FOR when they have boiled that mineral in a ſtrong lixivium of pot-aſhes, they ſuppoſe, that, as by the ſame operation, common ſulphur is diſſolved, ſo the menſtruum ſeeks out, and takes up, only the ſulphureous parts of the antimony: and as common ſulphur is precipitated out of the lixivium, wherein it is diſſolved, by ſprinkling on it vinegar, or ſome other acid; ſo they preſume, that what is ſtruck down the ſame way from the ſolution of antimony, made in the ſame menſtruum, muſt be the true ſulphur of that mineral; in which they are confirmed by the colour: and yet in reality, not only the ſulphur (ſuppoſing that there is one) but the other parts of the antimony will be diſſolved by a ſtrong lixivium, and the yellow powder, that is precipitated, is but a kind of crocus, which will ſometimes after a while (at leaſt in part) ſubſide of it ſelf, without the help of an acid. Nor does it convince me, that ſuch a body obtained from a mineral,

mineral, or metal, is its true ſulphur, that it may be made to burn; for unleſs the colour and ſmell of the flame concur, I ſhall be prone to ſuſpect, that the inflammability may be apt to riſe, partly from the great comminution made of the prepared body, and partly from the additament employed in preparing it. For theſe two, and perhaps even one of them, may contribute ſo much to the inflammable diſpoſition of a body, that little, or no true ſulphur will be neceſſary to make it burn. Of this I elſewhere give an inſtance in plates of copper; from which an equal weight of ſublimate has been diſtilled: for the remaining maſs will melt and burn at the flame of a candle, almoſt as readily as ſealing-wax. And of theſe inſtances I mention more in another paper, where I endeavour to ſhew, that combuſtible and inflammable bodies may be made up of parts or ingredients, that ſingly had not ſuch qualities. And yet the contrary of this is ſuppoſed in the chymical argument, that infers from theſe qualities the preſence of ſulphur in all thoſe mineral preparations, wherein they are found. Yet by this diſcourſe I would not be thought to derogate from the medical virtues, or other utilities of ſuch ſuppoſed ſulphurs. For they may be very uſeful concretes, though they be not true principles; the finer parts of the mineral being in ſome of theſe preparations extracted, and further divided, and perhaps very luckily aſſociated with the finer parts of the body, employed to act on them. By which means there may emerge new concretes of great virtue and uſe. And therefore I intend not to derogate from thoſe metalline ſulphurs, which ſome few maſters of chymical arcana reſerve with great care among the chiefeſt they are proud of. And that you may the better examine theſe fine crocus's, as I am apt to think moſt of them, and try both what they are, and what they do; if I can light on the proceſs, (for I dare not truſt my memory) I will at the end of this Appendix impart to you a way of preparing ſome of thoſe, that are made of metals, thoſe being accounted the moſt difficult as well as noble. And thus much I now remember of the trials I made according to this way; that I employed not any acid menſtruum, or liquor made of any particular ſalt, but a neutral or compounded ſalt; which, whilſt it was in actual fuſion, would diſſolve or corrode the very thinly laminated metal.

Of the Producibleneſs of Inflammability.

I Do no not look upon theſe ſubſtances as the true ſulphurs of the metals, that afford them, but rather (as I lately intimated) ſuſpect them to be a ſort of fine crocus's, and perhaps magiſteries; which by reaſon of the ſubtilty, and ſometimes fixtneſs of their parts, may prove uſeful to conſiderable purpoſes both in alchymy and phyſick.

BUT there is another ſort of bodies obtained from ſome minerals, and perhaps ſome metals too, that has a greater reſemblance to mineral ſulphur, than the newly-mentioned crocus's have.

TO this purpoſe I remember, that by putting aqua fortis, in a certain proportion, upon crude antimony, and, after it was almoſt totally diſtilled off, increaſing the fire till a dry ſubſtance began to ſublime, we had in the upper part of the retort a yellow and brittle ſubſtance, which being carefully ſeparated from the dark-coloured antimonial powder, that was alſo elevated by the force of the fire, appeared not only by its own colour, but that of its flame, and ſome other ſigns, to be much of the nature of common ſulphur. Nor is this the only way, whereby we have obtained ſuch a ſubſtance from crude antimony, from which (if I much miſ-remember not) I have had a yellow and combuſtible ſulphur, even without the help of a menſtruum.

PARACELSUS pretends to have a way of drawing ſulphurs from all metals; of which proceſs becauſe I have found little or no notice taken by chymiſts, I ſhall, for the oddneſs of it, and the reputation of the author (whom I look upon as a man of great experience in metalline affairs) ſubjoin it, as I find it among ſome of his looſe papers or fragments.

Sulphur Metallorum Theophraſti.

SULPHUR *metallorum eſt oleitas ex ipſis extracta, prædita virtutibus pro hominis ſalute. Sulphur aliud ex metallis, antequam ignem ſunt paſſa, elicitur, ut ex marchaſitis aureis, aut argenteis, &c. ſecundum nobilitatem mineræ, etiam nobile & præſtans:* ' & paucis interjectis, (ex-' tractio ſulphuris ex mineris metallicis.)' *Etiam fieri poteſt per lixivium acre & depuratiſſimum: ſed* (vel potius illa) *alia ſulphura pro intrinſeco corporis uſu minus ſunt commoda propter alkali cinerum, ex quo clavellatum conficimus erodens, & propter calcem, ex quibus talia fiunt lixivia. Sulphur ſic extractum poteſt ablui aqua dulci, & præcipitari. Digeſtio duplum requirit temporis. Debet & rectificari lixivium per ipſius ſublimationem ab omni reſidentia terreſtri, ne cum ipſo incorporentur talia ſulphura, & fiant corroſiva, ad perniciem ægrotorum: quod ne fiat dicta, debet fieri ſeparatio. (Tantum de crudis.)*

SED *jam fuſis & depuratis elicies ipſorum ſulphur: certa nobilior meliorque via non dabitur, quàm per aquam ſalis ſeu oleum ipſius præparatum, eo modo, quem in alchymia luculenter deſcripſi. Talis quippe aqua fundaliter & radicitus extrahit omnibus corporibus metallicis liquorem ipſorum naturalem, ſeu ſulphur & crocum præſtantiſſimum, tam pro operibus medicis, quàm pro chymicis. Reſolvit & frangit unumquodlibet metallum, ex natura ipſius metallica deducens in aliam pro varia intentione & induſtria laborantis.*

THUS far *Paracelſus*'s proceſs; but as I know not whether it be true, becauſe I am not able to reduce it to practice; ſo, becauſe I do not clearly underſtand his meaning, and what is the true nature of the inſtruments he would have us employ, I will not take upon me to determine, whether or no the ſulphurs, he teaches us to be obtainable by this method, be genuine ones, and fit to decide the queſtion we are now conſidering.

BUT whatever become of this obſcure Paracelſian proceſs, what I was ſaying about a

ſort of bodies leſs remote than the formerly deſcribed crocus's from the true ſulphurs of metals (if they have any ſuch) may well ſubſiſt. For I remember we have ſometimes (though the experiment did not always ſucceed) by cementing very thin plates of a certain metal with burnt allum, and afterwards dexterouſly elevating the more diſpoſed parts with ſal armoniac, obtained a ſublimate, from whence we ſeparated, by ablution with fair water, that diſſolved the ſalt, a ſubſtance, which, by its inflammability, appeared a kind of metalline ſulphur.

AND this may ſuffice touching the firſt ſcruple I thought fit to propoſe, concerning the factitious ſulphurs of metals and minerals. To proceed therefore now to my ſecond ſcruple, it may, I think, be ſuſpected, that even this ſort of bodies, which I have mentioned to have been drawn from a metal and from antimony, may not be the effects of a bare ſeparation of pre-exiſtent ſulphur, from the other ingredients of the bodies, that yielded them, but new concretes produced by the operation of the fire on thoſe bodies, and by the combination of ſome of their parts with thoſe of the additament, employed to obtain the ſulphurs. For, as far as I have yet ſeen, either ſalt-petre, crude or diſtilled, or menſtruums made of it, or of other ſalts, or elſe oleaginous liquors, are wont to be made uſe of on theſe occaſions. And it is very poſſible, that ſome of the more diſpoſed parts of theſe additaments may aſſociate themſelves with thoſe of the mineral or metal to be wrought upon; and ſo, from this combination of the ingredients, there may reſult a body of a new texture, which texture may diſpoſe it to be combuſtible, or inflammable, whether the ingredients in their ſeparate condition were ſo or not. As I remember I have elſewhere ſhown, that though aqua fortis be not inflammable, nor a piece of crude copper inflammable or combuſtible in a common moderate fire, yet the metal being diſſolved in aqua fortis, and the ſuperfluous moiſture warily exhaled, there will remain a fuſible concrete, wherein the copper being much comminuted, and its ſmall parts fitly aſſociated with the ſaline ones of the menſtruum, compoſe a kind of vitriol, that being held to the flame of a candle, or even of a piece of paper, will readily burn away in a flame finely coloured; and which may, if one pleaſe, be kept in a flame diſtinct from the other.

TO conclude what I have to ſay about my ſecond ſcruple; it ſeems not improbable, that if any of the metals be, by a fit menſtruum, or ſome other congruous additaments, reduced to parts minute enough, and that theſe parts be fitly aſſociated with ſome of thoſe of the menſtruum; the metal may thereby be brought to burn or flame, as I have ſucceſsfully tried, by a way elſewhere declared, upon gold it ſelf, whoſe ſulphur the chymiſts would have us look upon, as (what ſeems not very agreeable to the nature of ſulphur) incombuſtible; ſo that, for aught yet appears, it is allowable to ſuſpect, that the ſulphur obtained from this or that metal is not ſo much an elementary or hypoſtatical principle barely extracted, as it is a magiſtery, or ſome other new compound, made by the combination of the metalline particles with all, or ſome of the body, that works on them. But if a chymiſt will have metalline preparations of this kind to be ſulphurs; I may be allowed to make them ſerve for inſtances of the producibleneſs of ſulphurs.

YET theſe doubts concerning the ſulphurs of metals I propoſe but as ſuſpicions, to draw on further and more accurate trials; by which perchance they may be happily removed. And ſpeaking of the ſulphureous principle of mixt bodies, in that general notion of it, wherein the chymiſts often uſe it, and indeed muſt employ it; we may be thought to have ſaid enough to our preſent purpoſe, though we had left mineral ſulphurs untouch'd; ſince we have ſhewn, that inflammable parts of mixt bodies may be produced, and therefore cannot be ſafely affirmed to have all been pre-exiſtent in them,

---

OF THE

PRODUCTION OF MERCURY.

PART IV.

THE complaint I have divers times had occaſion to make, of the darkneſs and ambiguity, that chymiſts have allowed themſelves, if not affected, in treating of their three principles, is applicable to nothing more juſtly, than what they have written about that, which they call mercury. For when they would ſeem to tell us, what they mean by that principle, they are wont to do it in terms ſo looſe and ſo ambiguous, that the repreſentations they make of it, are more like to panegyricks, and ſometimes to riddles, than to clear definitions, or ſo much as good deſcriptions. Since then they have given us no ſettled notion of what they call mercury, but have left us to gueſs what they mean by it; I hope a miſtake about it (if I ſhould run into any) would appear pardonable. That which is agreed on by the moſt of chymiſts, when they ſpeak ſomewhat intelligibly of the principle they call mercury, is, that it is a crude ſubſtance, and that it is a volatile liquor;

liquor; which, by being ſo, may be diſtinguiſhed from the ſaline principles, eſpecially from the alkalizate or fixed ſalt; as it may alſo be from the oil or ſulphur, by its not being inflammable. But theſe marks will not diſcriminate it from phlegm, which is alſo a fugitive and uninflammable liquor; and therefore to make difference, they muſt add ſome other quality, ſuch as ſapor, (which yet agrees not to quickſilver itſelf) that is wanting to phlegm. So that, according to this doctrine, the nature of a chymical mercury or ſpirit will conſiſt in its being a liquor volatile, not inflammable like oil or ſulphur, nor yet inſipid like phlegm. How odd a principle this muſt be, that compriſes ſuch differing bodies, as are acid ſpirits, thoſe of nitre and vitriol; urinous, as thoſe of blood, hartſhorn, *&c.* and anonymous ones, as thoſe of guaiacum, honey, raiſins, *&c.* forced from their acidity; and the running mercuries of minerals and metals, as cinnabar, antimony, and lead; under one principle, which, to deſerve that name, ought to have all the portions of matter belonging to it homogeneous; I may ſafely leave any conſidering naturaliſt to judge. And therefore inſtead of taking further notice of this, it may ſuffice for my preſent purpoſe to mind you, that as for the mercuries or uninflammable ſpirits of vegetables and animals, I have endeavoured to ſhow their production, where I diſcourſe of that of ſpirits and volatile ſalts. And therefore I need but ſay ſomething of the production of mercury more properly ſo called, that is, running mercury: about which perhaps it will not be leſs acceptable to you, and I am ſure it will be leſs troubleſome to me, if I leave you to gather my opinion out of three papers, that were written for differing virtuoſi, at ſeveral times, and on diſtinct occaſions; upon which account, beſides thoſe particulars that relate to our preſent argument, you will perchance find ſome things, that you have not elſewhere met with.

Whether Mercury may be obtained from metals and minerals, or (to ſpeak chymically) An dentur mercurii corporum?

THAT there may be extracted or obtained from metals and minerals a fluid ſubſtance, in the form of running mercury, is the common opinion of chymiſts; in whoſe bodies we may meet with many proceſſes, to make theſe mercuries: which becauſe they are ſaid to be afforded by mineral, and eſpecially metalline bodies, theſe writers affect to call (how aptly I now examine not) *mercurios corporum.*

BUT notwithſtanding all this, divers of the more learned of the Spagyriſts themſelves have looked upon the pretenſion of other chymiſts to the art of making theſe mercuries as but a chymical brag; and ſome judicious modern writers, applauded therein by moſt of the mechanical philoſophers, have proceeded ſo far, as to explode all theſe mercuries of bodies as mere *non-entia chymica*; nay, ſome of them have not ſcrupled to cenſure all thoſe, who pretend to have ſeen or made any of them, as credulous or impoſtors.

IN the management of this controverſy, I confeſs I am not ſatisfied with either of the contending parties; and therefore I ſhall not refuſe to comply with your curioſity to receive in a few lines my thoughts, whether there are or may be any ſuch mercuries, as are diſputed of; yet I deſire leave to premiſe ſuch a ſtate of the controverſy, as I think will avoid ſome verbal janglings, and at leaſt acquaint you clearly with the ſenſe, wherein I deſire to have my opinion underſtood.

WAVING then, in the preſent inquiry, the queſtion, that may occur, 'whether or no 'the mercury ſaid to be obtained from metals 'and minerals are primitive ingredients, or 'hypoſtatical principles only extracted or ſepa-'rated from the bodies, that afforded them?' I ſhall propoſe the queſtion in theſe terms: 'Whether or no from a metal or mineral body 'there may, without the addition of any body, 'that we may be ſure has any common quick-'ſilver in it, be obtained, by the help of art, 'a ſubſtance reſembling common quickſilver, 'by being ponderous, fluid when actually cold, 'amalgamable with gold and ſome other me-'tals, and indiſpoſed to wet or ſtick to one's 'hand, or to bodies not of a metalline nature.'

TO give you now my preſent thoughts about this queſtion, I ſhall offer them to your conſideration, in the following propoſitions.

There are divers proceſſes of making the mercuries of bodies, that are ſo darkly delivered, that the generality of chymiſts cannot ſufficiently underſtand them, to be able to try them. For ſome of theſe proceſſes are ſo unknown in terms of art, which, for their great darkneſs or ambiguity, are not to be underſtood but by the authors themſelves, or thoſe, who are verſed in the more myſterious parts of hermetick philoſophy. And others there are of theſe proceſſes, that require ſome menſtruum, ſalts, or other inſtruments, that it is not in the power of ordinary chymiſts to procure. Inſtances of this kind may be frequently enough met with by thoſe, that have the curioſity to peruſe heedfully the writings of thoſe, that paſs for the adept philoſophers. And for a ſpecimen of ſuch proceſſes, I am content to annex to the cloſe of this paper the way delivered by *Lullius* of making mercury of ſilver, *Helmont*'s way of preparing mercury of lead, and *Paracelſus*'s way of extracting the mercuries of all metals. Prop. I.

There are divers proceſſes to make mercuries of bodies, that are either falſe, or accompanied with circumſtances, that make them unfit to be truſted. For there are of theſe proceſſes, that having been curiouſly tried by thoſe, that had a great deſire to find them true, have not been found to ſucceed at all in practice. Hence we have ſo many complaints of chymiſts, that have loſt their labour in indeavouring to make, according to *Beguinus*'s directions in his *Tyrocinium Chymicum*, the mercury of ſilver, though I do not take that to be one of the difficulteſt to be prepared; and he, that converſes much among thoſe, that have made attempts to make the mercuries of other bodies, as gold, antimony, *&c.* according to the vulgar proceſſes extant in chymical books, will (if I miſtake not) Prop. II.

not) find by their confeſſions, how little the events of their endeavours anſwer their labours and expectations. Nor do all the manuſcript proceſſes, that are communicated to private friends, as great arcana, much excel thoſe I have been ſpeaking of; as ſeveral of my acquaintance have complained to me, that they have found to their coſt. And here not to mention my own experience (which by the help of good principles made me timely deſiſt from unlikely attempts) amongſt many chymiſts I have known, I remember not to have found above three or four credible perſons, that would affirm to me, that they made, or ſaw made, the mercury of any metal or mineral (except of native cinnabar, which is the natural ore of quickſilver) in a conſtant way, by any proceſs he had found in printed books: ſo that ſo many of theſe proceſſes having been upon trial found falſe, wary men may be excuſed, if they do not think fit to believe other proceſſes of mercurification; which, though not yet tried, ſeemed not more probable, than thoſe, that have been already found ſo unſucceſsful, that not only many learned modern naturaliſts, but *Angelus Sala*, and divers others, eminent chymiſts themſelves, have publiſhed to the world, that theſe mercuries are to be found no where, but in the bragging chymiſts books and promiſes; and ſome have, as has been already intimated, gone ſo far as to brand all thoſe for cheats, that pretend they can make ſuch mercuries, and thoſe for credulous, that believe they can be made. But what I think of th[illegible]vere opinion, I ſhall quickly have occaſi[illegible] declare.

Prop. III. THERE *are ſome proceſſes, wherein it is thought, that the mercury of a metal or mineral is obtained; when indeed the obtained ſubſtance is miſnamed, or the true mercury, that is ſaid to be extracted, was put in, though in a diſguiſed form, by the operator.*

I WILL not here give inſtances of the ſubtle cheats, that may be put upon the ignorant and unwary, and ſometimes too upon the ſkilful, if they be not alſo cautious; but ſhall content my ſelf to illuſtrate the propoſition by a few known, and therefore innocent, inſtances. And firſt there are ſome, who finding themſelves unable to make the true mercuries of metals or minerals, make bold to aſcribe the name of mercuries to productions, whoſe qualities are very remote from thoſe, that are agreed to be eſſential to quickſilver. Thus *Glauberus* ſpeaks much of his mercury of Luna, which yet is far from being running mercury, or having the ponderoſity and other properties of true quickſilver. So *Angelus Sala* himſelf, in his anatomy of antimony, would have us to look upon the reguline parts of that mineral, as its mercury: becauſe he takes it for granted, it muſt contain mercury, and is pleaſed to fancy no other can be obtained from it. But the difference of the reguline part of antimony, and running mercury in point of conſiſtence, gravity, and other qualities, will, I preſume, indiſpoſe men to confound them. And therefore, I will proceed to confirm the ſecond part of our propoſition, by ſhewing, that the mercury obtained by ſome proceſſes, that may ſucceed, made part of the additament employed by the artiſt in the operations, and ſo was not properly extracted from the metal, but only recovered from the body, compounded of the metal and the additament. Of this, I remember, I have elſewhere given an eaſy inſtance, in a deluding experiment, that I long ſince ſhewed ſome virtuoſi, in whoſe preſence having mingled the filings of copper with a certain ſalt, and put them in a conveniently ſhaped veſſel of glaſs, I warily held it over a competent fire of well kindled charcoal, till the ſalt was thoroughly melted, and in part ſublimed: by which operation the copper ſeemed to be quite changed, eſpecially in colour, and was really become inflammable; and there remained in the lower part of the glaſs a pretty deal of running mercury, ſo that they would have gone away perſuaded, that they did ſee me make the mercury of Venus, if I had not been careful to undeceive them; which I did by telling them, that this quickſilver was only the common mercury, that lay diſguiſed in the compounded ſublimate I had imployed, together with the copper, which ſet the mercury at liberty from the corroſive ſalts it lay concealed in before, by preſenting them a metal more diſpoſed to be wrought on by them, than quickſilver is.

Prop. IV. IT *is poſſible to obtain, at leaſt from ſome metals and minerals, true running mercury, that cannot be juſtly thought to come merely from the additament.* This propoſition a chymiſt might more compendiouſly expreſs by turning it into this ſhort aſſertion, *Dantur mercurii corporum*; but I thought the words I have imployed would expreſs my ſenſe more warily and clearly; and yet, *ex abundanti*, I ſhall add this further explication, that though the propoſition ſpeaks affirmatively but of ſome metals and minerals; yet it does not deny, either that more minerals, or that all metals, may afford true running mercury: by which I underſtand (according to what I formerly noted) a mineral body fluid, opacous, exceeding ponderous, amalgamable with gold, and not apt to wet or ſtick to one's fingers, or any other bodies, beſides ſome metalline and mineral ones.

THAT ſuch a mercury may be obtained without the help of additaments, whereof quickſilver is an ingredient, I have been perſuaded to believe by the following obſervations.

I REMEMBER, that many years ago, having had an occaſion to diſtil copper with certain ſaline ſubſtances, I was not a little ſurpriſed to find in the veſſels (that had been luted together) ſome globules of running mercury, which I could not reaſonably ſuſpect to come from the additament, which was not ſublimate, nor any thing I could judge to contain quickſilver. And though the indiſpoſition I had to admit the mercuries of bodies, that ſo many learned men looked upon as non-entities, made me ſomewhat diffident of the genuineneſs of the mercury I had obtained, (whereof I had not quantity enough to make juſt trials) yet afterwards, when I found that accidents of the like

like nature had happened to ſeveral of my friends, I began to think, that what I had kept only for a few days as a queſtionable rarity, might really have been venereal mercury.

A LABORIOUS chymiſt of my acquaintance coming to viſit me once, when I was not well, was very earneſt with me to communicate to him the way of making the mercury of antimony and of Saturn; and when I told him, that I had no ſuch proceſſes of my own, and that I was far from believing thoſe, that I had met with in printed books, to be true ones, he would not acquieſce in this anſwer; but declaring, that he reſolved to make attempts to gain ſuch mercuries, and had rather do it by methods of my propoſing, than of his own deviſing, he preſſed me ſo much to let him know, which way I would go to work, in caſe I had the ſame deſign, that he then had, that to be rid of his importunity, I told him what on a ſudden came into my thoughts. And as ſometimes the mind being put to ſuch plunges, happens upon a lucky hit, and ſuch as much premeditation would not have led it to; ſo it happened at that time to me: for when I, becauſe of my diſtemper, had forgot this affair, the chymiſt, who was a plain honeſt man, came to me with great joy to give me thanks for the inſtructions I had given him, bringing along with him ſome mercury of antimony, and a little mercury of lead, that he had already made by the help of thoſe inſtructions; by purſuing which, he expected to obtain much more mercury from the minerals when they ſhould be longer digeſted with the concourſe of the air, in thoſe ſalts, that I had adviſed him to grind with them. This pleaſing ſucceſs of directions, which I had as to divers particulars forgotten, made me deſire them of the chymiſt; who, beginning to be proud of his attainment, when he perceived I remembered not ſo much as he thought I did, ungratefully delayed to bring me the account he promiſed me at firſt, till the plague reaching to the place, where he lived, and diſpatching him, deprived me of the hopes of ſatisfying my curioſity.

Two gentlemen of my acquaintance, but unacquainted with each other, working almoſt at the ſame time upon ſilver, did each of them, to his wonder, find parts of his ſilver turned into running mercury; with which odd accident each of them came to acquaint me, bringing along with them a little portion of the unexpected mercury. One of theſe portions a ſervant of mine loſt by miſtake, before I could try any thing with it; the other I found, by a trial unknown to the maker of it, not to be common, but metalline mercury; of which the chymiſt complained to me, that he had ſometimes had conſiderable quantities to his great loſs, becauſe much of the ſilver he employed in an operation, that he expected would prove lucriferous, being turned into quickſilver, had ſwallowed up all his gain; and this was that, which invited him to apply himſelf to me, hoping to be able to prevent or remedy this inconvenience by my advice; which I willingly gave him, but, becauſe of his departure out of *England*, could not know with what ſucceſs.

A FELLOW-TRAVELLER of mine, having occaſion to employ a ſaline body about lead, after he had finiſhed his operation, left the lead and ſalt together for ſome months, in a veſſel, which he laid by in a garret, where the air had acceſs to it: afterwards wanting ſuch a veſſel, and not being able to ſupply himſelf readily in the country (in which his experiment was made) he remembered this long neglected veſſel, and coming to ſee, whether it was fit for his turn, he found to his wonder, that though he had employed no mercurial body to work upon the lead, yet part of it was already turned into quickſilver, ſeparable by ſtraining, and more ſeemed in a near diſpoſition to admit the like change: whereupon he brought me, as a rarity, a part of the metal, and a little of the mercury, which I found by experience on gold to be of a nobler kind than common mercury. And I the leſs wondered at this mercurification, becauſe examining the gentleman that chanced to make it, I found the main thing he had employed in the operation was common or ſea-ſalt.

AN expert metalliſt of my acquaintance, being deſirous to try, what gold and ſilver he could get out of a fine Engliſh marchaſite I had preſented him at his deſire, he examined it according to his method, without any mercurial preparation, and found to his ſurpriſe, that, it yielded him, beſides other things, ſome running mercury, which he brought and gave me, becauſe it was afforded by the marchaſite I had preſented him.

THE mercury of antimony more than one of my friends have made, by unſuſpected additaments, ſuch as ſalts, that have nothing to do with ſublimate, or other compoſitions, whereof common mercury is an ingredient. One of theſe antimonial mercuries looked ſo oddly, that, though it were made by diſtillation, I had that curioſity to try, whether it would not operate on gold, in a peculiar manner; and having accordingly put a little fine calx of that metal (as about half a drachm or a drachm) into the palm of my hand, I added to it an equal or double weight of the above mentioned mercury; they immediately incorporated with a very manifeſt heat. And this was the quick way I uſed to examine other mercuries of bodies; for though this alone be not a certain ſign of a mercury's being of that ſort, becauſe I can obtain a mercury ſo qualified by another way than any I have hitherto mentioned; yet as their aſſertions and relations gave me ſufficient ground to conclude, that they had obtained thoſe mercuries from the bodies, that they affirm to have yielded them; ſo the readineſs of theſe mercuries to mix with gold, without the help of fire, and even to grow hot with it, which vulgar mercury will not do, confirmed, that they were metalline mercuries, rather than of the ſame kind with common quickſilver. And my way of obtaining incaleſcent mercury is ſo quite differing from any of thoſe, that there was not the leaſt cauſe to ſuſpect, that the mercuries of bodies we have been mentioning were ſo obtained, eſpecially ſince I knew, that my way was unknown to moſt of the perſons I have mentioned,

mentioned, and was practiſed by none of them.

As for the mercury of gold, though I think I have brought a great many parts of crude gold to aſſume a mercurial form, and to come over in that form by diſtillation, (whatever divers learned men think of the inſuperable fixity of gold;) yet I confeſs I have not ſeen any mercury, that I was ſatisfied did deſerve the name of the mercury of that metal. But happening to be once in a place, where a foreigner, that was a ſtranger to me, was ſhowing a friend of his, with whom I had ſome little acquaintance, a metalline experiment, that I confeſs, I could not but admire; (for this foreigner was ſo civil, becauſe I came ſo luckily in, as to let me be preſent at the experiment, though not to diſcover any thing of the drug he employed about it;) I made bold to aſk this civil traveller, who ſeemed a candid man, and I perceived had ſeen uncommon things, whether he had met with any way of making mercury of gold? To which he anſwered, that he knew no ſuch way himſelf, but that he met (ſomewhile before) with a very learned man, in compariſon of whom he confeſſed himſelf but a novice, that put ſome gold into a little phial, full of a certain menſtruum, which my relator owned he knew not how to prepare, and intimated to him, that this menſtruum would have a peculiar operation as well upon gold as ſilver. Afterward this relator having put the phial well ſtopt into his pocket, and carried it about with him, was, when he came home, and took it out to ſet it aſide, much ſurpriſed to find, inſtead of the gold he had ſeen put in, a pretty quantity of running mercury. Which the artiſt, who only lent him the menſtruum, did not ſeem to think ſtrange, when he was made acquainted with it.

If I would relate what I have heard from men, that I judge to be either eaſily deceivable themſelves, or concerned in point of intereſt to deceive others, or at leaſt of a vainglorious bragging humour, I might eaſily ſwell this diſcourſe to a greater bulk; but I have been careful to mention only thoſe relations, to which my ſelf, in ſpite of my long backwardneſs to believe ſuch things, ſaw cauſe to give aſſent. And if it be objected, theſe inſtances were but caſual experiments, notwithſtanding which there may be no ſettled way for the obtaining the mercuries of bodies; I might anſwer, that ſome paſſages of what has been lately delivered make it probable enough, that even ſettled ways of making the mercuries of bodies, or at leaſt of ſome of them, are not unknown to ſome artiſts; though for certain reaſons, and particularly for the ingratitude of many men, they do not think fit to divulge them. But to anſwer more home to the objection; I ſhall need only to ſay, that though moſt of the above recited experiments may be ſaid to have been made by chance, in this reſpect, that thoſe, that made them, did not principally deſign the obtaining of metalline or mineral mercuries; yet the effects produced were as naturally and neceſſarily conſequent to operations ſo managed as they were, as if the artiſt had directly deſigned them, as in ſome of the above mentioned relations they did. And it is not material for us to enquire, whether the quickſilver made by thoſe experiments be to be aſcribed to chance or ſkill; ſince whatever becomes of that queſtion, it is plain, that if metals and minerals could by either way be brought actually to afford running mercury, there needs no more to prove, that ſuch mercuries are really obtainable from them.

Doubts about the pre-exiſtence of running Mercury in metals.

The propoſed queſtion, Whether or no the mercuries of metals and minerals be principles pre-exiſtent in them, and only extracted from them, may to many ſeem, though it do not to you, a ſuperfluous enquiry; ſince the generality of chymiſts, of differing ages and countries, have reſolutely determined it in the affirmative: which is not at all to be wondered at, ſince according to their hypotheſis of the *tria prima*, (or three hypoſtatical principles) whereof they preſume all perfectly mixed bodies to be compoſed, metals, being of this ſort, muſt conſiſt of mercury, as well as of ſalt and ſulphur; and conſequently muſt afford it upon the analyſis of the body into its three primordial ingredients. But notwithſtanding all this, the problem ſeems to me difficult enough to be reſolved, partly becauſe ſuppoſing, that there be true metalline mercuries preparable by chymiſts, they very ſtudiouſly conceal the ways of preparation; and partly, becauſe as it is very difficult to obtain any of the factitious mercuries, wherewith to make ſuch lucriferous trials, as a naturaliſt would deſign; ſo thoſe few authors, that affirm themſelves to have poſſeſſed ſuch mercuries, have given us but an exceeding lame and defective account of them, not mentioning thoſe particulars, which are moſt proper and deſirable, in order to the paſſing a right judgment about them. I pretend not therefore to anſwer your queſtion otherwiſe than conjecturally, till I ſhall be better furniſhed with matters of fact. But in the mean while, that I may comply with your curioſity, as much as I ſafely can, I ſhall confeſs to you, that for the preſent I am, by as much information as yet I have had, inclined to think, that the mercuries obtained from metals do not clearly appear to have been preexiſtent in them, and only ſeparated from them by the artiſt, but that I think, that at leaſt ſome of them may be rather fluid magiſteries of metals, than their extracted principles. One of the moſt obvious things, that ſuggeſted this ſuſpicion to me, was, that whilſt ſome metals, as tin and lead, are in fuſion, they would, to one, that ſhould not know of their being melted, appear to be many parcels of mercury; ſince like it they are fluid and ponderous, and ſtick not to crucibles, or ſtones, bricks, or almoſt any other bodies, except ſome metalline ones, divers of which they will eaſily pierce into, as quickſilver does into ſilver or gold; ſo that if the fluidity of theſe metals were permanent, they might paſs for mercuries. And if in the moon and ſome of the other ſtars, as there are mountains, ſo there are metalline

mines, in caſe the heat of the climate or of the ſoil ſhould keep them conſtantly in ſuch a degree of heat, as we here find ſufficient to melt lead (which we know needs not be very intenſe) theſe metals would there emulate the nature of mercuries, as I have learned from travellers, that in divers parts of the torrid zone, what would here be butter, is fluid as well as unctuous like oil, and is ſold like other liquors, by meaſure, not by weight. And an inquiſitive man, who is a ſcholar as well as a traveller, aſſured me, that whilſt he was in ſome parts of the *Indies*, he furniſhed himſelf with ſome liquid ſubſtances afforded by wounded plants, that as ſoon as he came near *Europe*, and not before, turned into conſiſtent and pulverable bodies; it did not therefore ſeem to me impoſſible, that the piercing ſalts, and other ſubtile bodies, employed by artiſts about the mercurification (as ſome ſtyle it) of metals, may either by the agility of their own nature, or by ſo altering the ſhapes, and looſing the wonted coheſion of the metalline corpuſcles, bring them to have ſuch a texture and ſuch pores, as may enable the ethereal ſubſtance, whereto ſo many other bodies owe their fluidity, to agitate them. Theſe cauſes, I ſay, or ſome other, that may be propoſed, may poſſibly keep the prepared metal fluid; as we ſee, that though camphire be a conſiſtent and tough body, yet ſome nitrous ſpirits of aqua fortis will eaſily penetrate it, and may be brought to ſtay ſo long with it, that I have, for curioſity-ſake, kept the camphire ſeveral years without loſs of its fluidity, which I found that this kind of liquor would retain, though for trial-ſake I expoſed it to intenſe degrees of cold, ſuch as would freeze divers other liquors. Nor did it to me ſeem impoſſible, that a ſmall quantity of appropriated additament might ſuffice to put a metal into a ſtate of fluidity; for ſince we ſee, that the vapour of lead can arreſt quickſilver, and make it a conſiſtent body; and ſince *Helmont* aſſures us *, that the liquor alkaheſt being once abſtracted from running mercury, deprives it, and that almoſt irrecoverably, of its fluidity, ſo as to make it pulverable; it appears not, why nature or art may not be able to ſupply ſome corpuſcles, that may expel or diſable thoſe, that keep a metal in the form of a fluid body; and eſpecially ſince, as I have elſewhere ſhewn, the matter of metals themſelves may (at leaſt ſometimes) have been a liquor, or ſome other fluid body.

ANOTHER reaſon, that induced me to ſuſpect, that the mercuries of metals and minerals are not, as it is preſumed, merely extracted principles or ingredients, was, that I have obſerved a greater diſſimilitude between mercuries all of them quick, and furniſhed with all, that is requiſite to make them paſs for true mercuries, than will comport with the ſuppoſition, that they are ſimple and primordial bodies, barely extricated from the others, with which they were at firſt commixed. But this argument being the ſubject of an entire, though ſhort, diſcourſe, (of the diſſimilitude of running mercury) I need not inlarge on it in this place.

IT did alſo ſtrengthen my ſuſpicion to conſider, that the chymiſts, that talk of the mercuries they have drawn from metals, are not wont to tell us, what other ingredients they obtained by their ſuppoſed analyſes, which left me dubious, whether they obtained any ſalt and ſulphur, or not; and of what nature thoſe ſubſtances were, that they did obtain. For if theſe were not true ſalt and ſulphur, the genuineneſs of the analyſis might be queſtioned; becauſe it may be alledged, that the chymical operation and the additament turning ſome parts of the metal into decompounded bodies, which muſt be acknowledged not to have been (in ſuch) forms pre-exiſtent in them, may alſo have by change of texture turned ſome other parts of the metal into the form of mercury.

To the foregoing conſiderations, afforded me chiefly by the nature of the thing, I ſhall, for the ſake of thoſe, that are moved by the authority of adept philoſophers, as they call them, add that, which among them ought to paſs for a proof from experience. For *Raymund Lully*, whom I take to be one of the greateſt chymical philoſophers, whoſe writings are come to our hands, though in many of his other books he ſpeaks of mercury in a dark and allegorical ſenſe; yet in that excellent little tract, which he calls his *Clavicula*, he delivers a proceſs, (which is not to be wrought with vulgar menſtruums, though they bear the ſame names with thoſe he preſcribes and names) from the cloſe whereof it ſeems manifeſt, that his deſign was not to extract a pre-exiſtent quickſilver out of the metal propoſed, but to turn the metal into quickſilver; ſince he orders and directs us to proſecute the mercurification, till the obtained quickſilver be equal in weight to the ſilver, that was to be tranſmuted. And partly upon this I have ventured to ground the foregoing paradox; that the mercuries of bodies are rather magiſteries than extracts. For in this Lullian proceſs, it appears not, that the mercurial principle was extracted from the ſalt and ſulphur, but rather that the body of the metal (without being analyzed) was turned into mercury. And though magiſtery be a term variouſly enough employed by chymiſts, and particularly uſed by *Paracelſus* to ſignify very different things; yet the beſt notion I know of it, and that, which I find authorized even by *Paracelſus* in ſome paſſages, where he expreſſes himſelf more diſtinctly, is, that it is a preparation, whereby there is not an analyſis made of the body aſſigned, nor an extraction of this or that principle, but the whole, or very near the whole body, by the help of ſome additament greater or leſs, is turned into a body of another kind. As when iron or copper by an acid menſtruum, that corrodes and aſſociates itſelf with it, is turned into vitriol of Mars or of Venus; and quickſilver having a ſufficient quantity of aqua fortis ſtrongly abſtracted from it, is changed into a red precipitate; or by being ſublimed up with common ſulphur, is turned into cinnabar; or, to give yet a more appoſite example, when quickſilver (which

Vide Lullium in Clavicula, cap. 2.

* *Eſt ſcilicet* (Corallatus Paracelſi) *Mercurius, a quo liquor Alkaheſt ſemel diſtillatus eſt, reſidetque in fundo coagulatus & pulverabilis, nequicquam in pondere auctus aut diminutus.* Helmontius in Scripto de Arcanis Paracelſi.

(which is the body we treat of) is by the lasting operation of the fire, without external additaments, at least distinct from the igneous particles, turned into a red powder, that chymists call *Præcipitate per se.*

I HAVE received credible information, and some proof too, that there is a place in *Transylvania*, where portions of running mercury, which, when they fall out of the earth, and lie a while in the air, do of themselves coagulate into permanently hard bodies: so little a distance hath nature her self there put between the mercurial fluidity, and the solid consistence of the same portion of matter. So that if so small a thing (and perhaps unponderable as well as invisible) as the contact of the air can expel, is able by its presence to retain a mineral body in the form of a true running mercury, as well as by its recess to leave a solid body; I see not why it should be impossible for art, to intercluse some very minute and restless particles, which, by their various and incessant motions, may keep a metalline body in the state of fluidity, much after some such way, as I lately noted, that the spirits of nitre did, for whole years together, keep camphire in the form of a liquid oil.

HAVING now proposed some of the considerations, that inclined me to think, that the mercuries obtained from metals and minerals may not have been pre-existent in them; the impartiality, that, I think, becomes a naturalist, obliges me to take notice also of those things, that occurred to me, in favour of the received opinion of the chymists, in behalf of which I objected to my self divers specious arguments.

OF these, the first was the general consent of chymists, who take it for granted, that all metals are composed of mercury as a material principle, and commonly more copious, than any other constituent part of those bodies; but this being an argument drawn only from authority was of small weight with me, in a controversy properly determinable by reason and experience.

2. A SECOND objection was afforded me, by many processes I had met with in chymists books, to extract the mercuries, as well as the sulphurs and salts of metals. But neither did this argument appear to me of any great moment, for most of these processes I looked upon as fictitious things; which, if the authors of them had taken the pains to try themselves, they would have found not to succeed in practice; and scarce any of them was so skilfully framed, as to satisfy a considering naturalist, in case it had succeeded, that the obtained mercury was a pure principle only separated or extracted from the other ingredients of the metals, and not a result of some metalline parts conjoined with some parts of the additament; as it seemed manifest enough to me, that the supposed salts of metals, that are pretended to be made by such preparations, are not the principles of such metals, but new concretions, and indeed not simple, but decompounded bodies; as is evident in the salt or sugar of lead made with the spirit of vinegar, and in the salt of steel made with that, or other acids.

3. A THIRD objection, and of greater weight, seemed derivable from this consideration, that quicksilver easily amalgams with metals, because of its cognation with the mercurial part these bodies abound with.

4. AND this argument appeared capable of being strengthened by a more considerable one; which is, that the gravity of the metals is such, as cannot reasonably be deduced from any other cause, than an abundance of the mercurial principle, there being no other bodies (known to us) besides quicksilver, that are near so ponderous as metals.

THESE two objections I thought fit to couch together, to be able, in fewer words, to answer them both: I considered then, that amalgamation being, in effect, but a kind of dissolution of metals in a menstruum or fluid body; (for such mercury is, in reference to them) there is no necessity, that the solvent should find in the metal a copious ingredient just of its own nature; for dissolution depends not so much upon the pretended cognation between the solvent and the body it is to work on, as upon the congruity, as to size and figure, between the pores of the latter and the corpuscles of the former; as may appear by the solution of ivory and hartshorn (which belong to the animal kingdom) that may be made with aqua fortis; and by that, which I have elsewhere shewn may be made of zink, and even of copper, by the spirit of vinegar, the urinous spirit of sal armoniac, and spirit of vitriol separately imployed; though the first of them be a menstruum drawn from a vegetable, the second from an animal, the third from a mineral substance. And as for amalgamations themselves, I observe, that the facility mercury finds in joining with a metal, does not barely depend upon the plenty of the mercurial ingredient, contained in the metal; at least if the greater ponderosity, or specifick gravity of the metal depend upon the copiousness of the same mercurial principle, or ingredient, as the fourth objection supposeth: for we find by experience, that mercury will far more easily amalgam with tin than with copper, which, yet, is much more heavy than it; nay, than with silver, which is a good deal heavier, (in specie) than copper; and is by chymists presumed to be much nearer of kin to mercury than is tin. To which I shall add, that although Mars be specifically heavier than tin, yet it is far from being more easily amalgamable with mercury; that though tin will readily admit this mineral liquor, without the help of heat, there is no way vulgarly known to chymists to make an immediate amalgam between mercury and Mars. So that one of the two objections, I lately joined together, must be declined; since by the trials I have purposely made, it appears, that either the disposition of metals to amalgamate with mercury does not barely depend upon the supposed plenty of mercury contained in the metal; or else that

the

the greatneſs of the ſpecifick gravity does not depend upon the more plentiful participation of that mercurial ingredient. Although the fourth objection be built upon a ſuppoſition, that the great ponderouſneſs of metals, in compariſon of other bodies, can proceed from no other cauſe than the great quantity of mercury they contain; I conſidered too, that it might be juſtly demanded, whence mercury it ſelf, as well as whence metals, derive their great ponderoſity; and I ſee not, why it may not be ſaid, that both the one and the other own it to the ſolidity, and cloſe order, of the corpuſcles they conſiſt of; to which qualification it is not eſſential, that the portion of matter endued with them be in a ſtate of fluidity, rather than in one of conſiſtence: as on the contrary we ſee, that gold and lead are exceeding ponderous bodies, as well when they are in fuſion, as when they are cold and hard; and ſo in quickſilver, as well in its wonted and liquid form, as when it is coagulated, as chymiſts ſuppoſe, by the vapour of lead.

BUT this will be ſomewhat further cleared in what I ſhall ſay to the fifth and laſt objection, that my thoughts ſuggeſted to me, and which philoſophical candour forbids me to conceal; though I find it eaſier to be propoſed than anſwered. It may be then alledged in the fifth place; that the mercuries of metals muſt needs be but partial principles of them, ſince quickſilver being confeſſedly heavier than either the ſulphureous or ſaline principle, and being ſpecifically heavier, than almoſt any metal it ſelf; the gravity of a metal cannot reaſonably be ſuppoſed to proceed from the whole body of the metal, but only from ſome one ingredient heavier in ſpecie than the reſt, and, than the metal it ſelf. And this ingredient or principle can be no other, than the moſt ponderous body, mercury.

THIS difficulty, I confeſs, does keep me yet in ſome ſuſpence, till I have further opportunity, to make ſuch trials, as I think proper to clear it. Yet in the mean time, I ſhall offer ſome few things, which perhaps may leſſen it, if not quite remove it.

I CONSIDER then, that there is no neceſſity to ſuppoſe, that metals, of what denomination ſoever, as tin, iron, or ſilver, gold, are bodies perfectly homogeneous, though they ſeem ſuch to our eyes. This ſuppoſition I elſewhere purpoſely diſcourſe of, but in this place I need not ſpend time about it; ſince the chymiſts (who are thoſe I now reaſon with) do not only allow, but teach it, ſince they will have metals as well as other mixt bodies to conſiſt of three hypoſtatical principles, whereof mercury is one, although it muſt be much heavier in ſpecie, than either the ſalt or the ſulphur it is blended with; becauſe it is from the participation of that ingredient, that they derive the great ponderouſneſs, which metals have, in compariſon of other bodies.

AND to this granted ſuppoſition, I ſee not why it ſhould be abſurd, to add this other, that the more ſolid and heavy particles or corpuſcles of metal may lie in it, not in the form of fluid or mercurial, but conſiſtent parts, and that theſe may be more diſpoſed than the reſt, to be brought by chymical additaments and the operation of the fire into the form of a running mercury. Nor ought it to be judged incredible, that the fore-mentioned ſolid portion of the metal ſhould be more ponderous than quickſilver, ſince, as I have often tried, gold, though a conſiſtent body, is far heavier than quickſilver, to the bare participation whereof gold cannot owe its ſpecifick gravity.

IF this hypotheſis be admitted, it will be eaſy to give an account, how the mercury of a metal may be heavier in ſpecie (that is, bulk for bulk) than the metal that afforded it; for the difficulty is eaſily reſolved, by ſaying, that the ſolid parts, which by the chymical operation are reduced into the form of quickſilver, were far more ponderous in kind, than the other parts of the metal, which being alſo aſſociated with them, did, by their comparative lightneſs, make the entire metal leſs heavy (if the bulks be equalled) than an aggregate or convention of all the ſolid parts alone would have been. Which may be illuſtrated by what I have heedfully obſerved, of the decrement of ſpecifick gravity, ſuſtained by quickſilver, when it is united by ſublimation either with ſulphur into cinnabar, or with ſalts in corroſive ſublimate.

BUT I muſt not diſſemble, that againſt the foregoing diſcourſe there occurr'd to me a couple of arguments (that I have not met with amongſt chymiſts) whereof the *latter* is very conſiderable. For I foreſaw it might be alledged, firſt, that the mercuries of metals being in a liquid form, could not well be ſuppoſed to be ſo cloſe and ponderous bodies, as our hypotheſis requires: and next, that we our ſelves admit an experiment of *Raymund Lully*, whereby he pretends to reduce the whole body of ſilver into mercury, which is a heavier ſubſtance than ſilver; and in this caſe we cannot have recourſe to this anſwer, that the corpuſcles, which aſſume the form of mercury, were far more ponderous, than the others, that concurred with them to compoſe the metal.

THIS twofold objection I do not pretend to anſwer at once, but may perhaps enervate it by degrees.

AND firſt, though it be very poſſible, that a pretty quantity of additament may be employed about the mercurification (to ſpeak in the chymiſts language) of a metal, yet there ſhall really and finally adhere to the metalline parts, but a very ſmall proportion of additament, that will continue with them, and keep them in a mercurial flux. And it may appear the more credible, that a very ſmall quantity of additional matter may have a very great ſtroke in altering the conſiſtence of that, which is obtained from a metal, as its moſt ponderous portion, if you conſider with me, that the bare acceſſion of igneous particles, is able in time, to turn running mercury into that red powder, which chymiſts call *Præcipitate per ſe*: and I have found by trials purpoſely made, and elſewhere related, that this powder

without any further additament may be reduced into running mercury. Nor muſt I pretermit, on this occaſion, a notable paſſage I remember to have met with in *Helmont*, who relates, that by the abſtraction of the liquor alkaheſt (which is wont to come all over in diſtillation from common quickſilver) he did quite deprive it of its fluidity, and turned it into a conſiſtent body, and even into a fixed one; whereby you may ſee how little a quantity of matter will ſerve to change the conſiſtence of a body of a mercurial nature.

BESIDES that, a fluid form does not always argue the lightneſs of the body, that it is found in, ſince it may conſiſt of particles ſo ſolid and ſo numerous, that, notwithſtanding their inteſtine motion, the body they compoſe may be very ponderous: as may appear by red-hot iron, melted lead, and, which is an inſtance appoſite to our purpoſe, in common quickſilver, which though fluid is heavier than any known body in the world, gold excepted.

BUT I conſider farther, that though the ſolid portion of a metal retain more of the additaments imployed to bring it into the form of mercury, than it can be proved to contain; yet this diſadvantage may be compenſated by the new diſpoſition of parts, that the mercurified portion acquires by the operation, that turns it into a liquor, and may be ſuppoſed to bring the parts to a cloſer, or otherwiſe a more expedient order than they were in before: as ice when thawed takes up leſs room in the form of water, than it did before it became a liquor. I ſee no impoſſibility, that the ſpecifick gravity of metalline bodies may be increaſed or diminiſhed by ſuch ſmall proportions of additaments, as do not at all conſiderably add to their abſolute gravity. This the chymiſts ought not to deny, if they conſider what themſelves grant of the efficacy of what they call the philoſophers ſtone, whereof they tell us, that one grain, if it be of a nobler order or degree, may tranſmute a whole pound of quickſilver into perfect gold; and conſequently the ſpecifick gravity of a metal is notably changed by an additament, which (according to the differing pounds uſed in ſeveral countries) amounts not perhaps to the ſixth or ſeventh thouſandth part of its weight. Beſides, the tranſmuting powder being a compounded body, whereof but part is gold, may probably be ſuppoſed to be more light in ſpecie than the metal, that by addition of it is produced; which being pure gold, is the ponderouſeſt body yet known to us. And to confirm the argument, I ſhall add, that there is a way, though I pretend not to know it, of making a metal far lighter in ſpecie, than it naturally is, by the addition of leſs than a hundredth part of its weight, as experience has convinced me.

WHEREFORE to come now to the grand objection furniſhed by *Lully*'s lately-mentioned experiment, it will not preſently follow, that if the whole body of a metal be brought into a mercurial form, this mercury will ſwallow up and deſtroy our hypotheſis: for though I grant, that, in this caſe, it cannot be ſaid, as in the former caſes (wherein a part only of the metal is mercurified,) it may be, that the obtained quickſilver conſiſts of the more ſolid and ponderous parts of the metal; yet it may be ſtill ſaid, that, for aught we know, the mercury, produced by the reduction of the whole metal into a fluid form, may be ſpecifically lighter than common mercury, and ſo cannot be neceſſarily concluded to be ſpecifically heavier than the metal, that afforded it. I lately imployed the words, *for aught we know*, becauſe we are now upon the caſe, wherein philoſophical candour invited me to acknowledge, that I wanted further trials to give my ſelf full ſatisfaction: for although I have had portions of the mercuries of more than one or two metals, yet it was but in ſmall quantities; ſo that the other trials, I had the curioſity to make with them, kept me from examining their ſpecifick gravity, and from finding by an hydroſtatical way, that I have elſewhere declared, whether they were not lighter in ſpecie than inferiour metals, and conſequently than common mercury. For that quickſilver may be ſpecifically lighter than the metal that affords it, I think the chymiſts cannot reaſonably refuſe to grant; ſince they allow, that running mercury may be obtained from gold, and tell us great matters of it, becauſe of its proceeding from ſo noble a body. Now if this golden mercury be ſaid, becauſe of the ſuppoſed reſemblance of all mercuries, to be of the ſame ſpecifick weight with common quickſilver, then I have a notable inſtance of a mercury, that is conſiderably lighter in ſpecie, than the metal, that afforded it. And therefore, till experience have manifeſted the contrary, it will not be abſurd to preſume, that the mercuries of other metals may likewiſe be lighter in ſpecie, than the reſpective bodies, from which they were obtained: but if it be ſaid, that this golden mercury may perhaps be as ponderous as gold itſelf, or even more, then it is plain, that it is poſſible for a metalline body, notwithſtanding its being reduced into the form of a fluid, to be equiponderant to the metal, that afforded it. And that I may not ſeem to argue altogether from the conceſſions the chymiſts ought to make, I will add, by way of confirmation, a couple of things, that perhaps you will think ſomewhat ſtrange. Whereof the former is, that it is poſſible for a metalline body to reſemble another in all the manifeſt qualities, whereby artiſts are wont to examine them, and yet they differ much from it in ſpecifick gravity: as I had once opportunity to obſerve in a metal, that was not only white (within and without) like ſilver, and very malleable, but did, when I purpoſely examined it, endure cupellation, and paſſed for, and was reputed by a very eminent artiſt, that ſent it me to examine, to be good ſilver in all proofs; and yet this metal I found by hydroſtatical trials to be much lighter in ſpecie, than common ſilver. And if the famous perſon, that ſent it me, was not miſtaken, (for ſo I muſt not think he would knowingly miſinform me,) this odd metal may yield me a notable inſtance to my preſent purpoſe, ſince he affirmed this metal to be made without the addition of any metalline body of quickſilver; which, if this be ſo,

muſt, by a change of texture, have made a conſiderable loſs of its ſpecifick gravity. But to proceed to my ſecond inſtance, which will be yet more oppoſite; I ſhall add, that once I had a mercury, which amongſt other remarkable properties, that belong not to this argument, had a very ſtrange one; namely, that it was conſiderably heavier in ſpecie than common mercury (as I found and ſhewed to a great virtuoſo by hydroſtatical trial,) though it was made of a body no heavier than common mercury, and by the help of additaments, which were much lighter than common mercury. And this was ſo far from being a more groſs and ſluggiſh kind of quickſilver than the ordinary, that it looked very fine, and was very agile, and had, before I examined it, been more than once diſtilled. By this it may appear, that from hence, *that a body is in a mercurial form*, we cannot ſafely determine what degree of ſpecifick gravity it has. For ſince by this laſt example it appears, that a ſort of quickſilver may be far more ponderous than common quickſilver; it ſeems not unreaſonable, that a ſort of quickſilver may be far lighter than common mercury, and ſo perhaps lighter than the metals, that were reduced into that form: it being far leſs likely, that the former ſhould be produced than the latter, in regard there is but one mineral body in the world, that we know of, at all heavier than common quickſilver; whereas there are many of thoſe, that are capable of being aſſociated with it, that are far lighter than it.

BUT, as I intimated above, I am unwilling to ſpeak ſo poſitively about this matter as I might do, if I had opportunity to make the trials I would with the mercuries of bodies: only thus much I ſhall venture to ſay, that, for aught yet appears, the argument, I have been anſwering all this while, is not cogent, ſince it is built upon a ſuppoſition, that the mercuries afforded by metals and minerals muſt be of the ſame weight with common mercury; which is not only a prooſleſs aſſertion, but repugnant to the experiment lately mentioned of the diſtilled mercury, that was heavier than common mercury, and to the preſumption derived thence, that there may be bodies, in a mercurial form, more light in ſpecie than common mercury. And whatever becomes of the opinion I incline to; the argument I have been examining of the chymiſts, may be invalidated by what I have ſaid, where I took notice of the notable exceſs of ponderoſity, that pure gold has in regard of common quickſilver: for by that inſtance it plainly appears, that it is not to the participation of common mercury, that metals muſt neceſſarily owe their great ponderoſity, but that nature (and art too) may contrive the parts of a body into ſo cloſe an order, as to make that body (whether ſolid or fluid) more ponderous, bulk for bulk, than common quickſilver it ſelf.

HAVING now diſpatched what I intended to ſay in the foregoing diſcourſe, it remains, that I perform the promiſe I made, of adding the ways of mercurification (as chymiſts ſpeak) above referred to, as delivered by *Paracelſus*, *Helmont*, and *Lully*: about which I muſt give you this advertiſement, that beſides the obſcurities, and imperfections, that a moderate degree of attention may enable you to diſcover in theſe proceſſes, underſtood in the literal ſenſe, there are, if I much miſtake not, ſome affected equivocations in terms, that ſeem very plain, and free from ſuſpicion of ambiguity. As for inſtance, though the word *ſal armoniacum* ſeem to be of this ſort, yet amongſt Hermetick philoſophers it often ſignifies, not common ſal armoniac, which is far from being able to perform the effects they aſcribe to theirs, but a very differing and much more noble and operative thing; which, becauſe it may be ſublimed like common ſal armoniac, they are pleaſed to call by that name. And though ſometimes they give it the title of *ſal armoniacum philoſophorum*, yet oftentimes they omit the diſcriminating epithet, eſpecially in philoſophical proceſſes, (that is, ſuch as thoſe, wherein they deliver their higher arcana,) of which ſort are many of *Paracelſus*'s proceſſes, and more (not to ſay moſt) of *Lully*'s. What is meant by *ſal armoniacum philoſophorum*, I think it needleſs to tell you here, (but may perchance do it on another occaſion;) ſince that compoſition requires an ingredient, that neither of us is furniſhed with, and that you cannot procure. There may be other ambiguities in the following proceſſes, that will not be eaſily diſcovered, but by ſuch as are verſed in the myſterious language, which ſome would call canting, of the Hermetick philoſophers. But, I think, I have ſaid enough already to ſhew, that the annexed proceſſes are fit to confirm, what is delivered upon the firſt Propoſition of the foregoing diſcourſe; and therefore without offering to explain them, I ſhall ſubjoin them in the proper terms of the reſpective authors.

Ratio extrahendi ex omnibus metallis mercurium Paracelſica.

Hæc extractio (ſcilicet mercurii ex metallis) fit per aquam mercurialem, quæ nec *Joanni de Rupeſciſſa*, nec aliis, quicquid etiam jactitent, cognita fuit. Ideoque diligenter eſt cognoſcenda, & indefeſſo labore tractanda. Hoc ergo pacto paretur dicta aqua mercurialis.

℞. ℔ iii. *Mercurii ſublimati ſepties per vitriolum, ſal nitri, & alumen.*

SALIS armoniaci, ter à ſale ſublimati & clari & albi iß. *Trita ſimul & alcolizata ſublima in ſublimatorio per arenam, horis* 9. *Ubi refrixerit, ſublimatum cum penna detrahito, & cum reliquo ſublima, ut prius. Hanc operationem quater repete, donec amplius non ſublimetur, & in fundo maſſa nigra maneat, inſtar ceræ, fluens. Refrigeratam exime, & tritam rurſus in patinâ vitreâ ſæpius cum ſalis armoniaci aquâ, ſ. autem præparata, imbibe, & ſua ſponte coagulatam rurſus imbibe & ſicca, ad* 9. *ſeu* 10. *uſque vices, donec ferè non ulterius coaguletur. Tritum ſubtiliter ſupra marmor in loco humido ſolve in oleum pulchrum, quod rectificabis per diſtillationem in cineribus, ab omnibus fæcibus & reſidentia.*

Hanc

Hanc aquam omnium facile principem diligenter aſſervabis, cujus ℞ unc. viii. *& impone laminas opt. ſolis ac lunæ, optimè mundatas, pondere unc.* iß. *vitro clauſo repone ad digeſtionem in cineres calidos horis* 8. *Corpus tuum videbis in fundo vaſis tranſmutatum in ſubtilem vaporem ſeu mercurium. Factâ ſolutione totius aquæ mercurialis per alembicum leńto igne à prima materia ſublimando ſepara, & in vitreo vaſculo diligenter aſſervato. Habebis hoc pacto veriſſimum mercurium corporis.* Paracelſus in Man. de lapide Philoſophorum.

SENSI (ſays he) *cruditatem Saturni, pinguedine fixorum ſalium ſolubilem, ſolo quandoque igne carptim delebilem, ſicque dividi compoſiti partes, crudumque argentum vivum currere permitti. Sulphur fugitivum ſuperans in Saturno trahere ad volatum, fixum, inſeparabiliter junctum. Quodque expediet imprimis Saturni ſublimatio. Cujus expreſſione nulla eſt elevati ad reſidens coloris aut ſubſtantiæ differentia. Unde etiam caloris, fuſionis, & mollitiei cauſis, poſt calcinationes & redactiones, reſiduis medullitus, ſine igne fuſionem, ſolitamque mollitiem minimè refutat.* Helmontius, in Poteſt. medicaminum. num. 40.

Extractio mercurii à corpore perfecto.

RE C. unc. i. *calcis lunæ appellatæ, calcinetur modo quo dicitur in fine noſtri magiſterii operis, quæ quidem calx teratur ſuper porfidum in pulverem ſubtilem, quem pulverem imbiberis bis, ter, quater in die, cum optimo oleo tartari, facto eo modo, quo dicetur in fine noſtri, deſiccando ad ſolem quouſque dicta calx abſorbuerit de dicto oleo* 4 *aut* 5 *partes, plus quàm fuit ipſa calx, terendo ſemper ſuper porfidum, ut dictum eſt, & in fine bene deſiccetur calx, ut benè poſſit in pulverem redigi. Et quando fuerit bene pulverizata, ponatur in metreto cum collo longo. Ponatis de noſtro menſtruali fœtenti, facto de duabus partibus vitrioli rubei, & una ſalis petræ, & prædictum menſtruum prius diſtilletur ſepties, & bene rectificetur, ſeparando fæces terreſtres in tantum, quod prædictum menſtruale ſit totum eſſentiale. Deinde lutetur benè metretum, & ponatur ad ignem cinerum, cum parvo igne carbonum, quouſque videris materiam bullire & diſſolvi. Deinde ſic ſupra cineres diſtilla, donec amiſerit menſtruum, & materia fuerit frigida totaliter: cum frigidum fuerit, vas aperiatur, & materia, quæ frigida eſt, ponatur in alio vaſe bene mundo, cum ſua cappa bene lutata ad furnum ſupra cineres, & luto bene deſiccato, fiat ignis paulatim in principio, quouſque totam recipias aquam ipſius. Poſtea augeatur ignis, quouſque materia bene fuerit deſiccata, & ſpiritus fœtentes ſint ad cappam, & in receptorio jam exaltati. Et dum tale ſignum videbis apparere, dimittatur vas infrigidari, ignem minuendo. Et poſt refrigerationem vaſis, extrahatur materia, & in pulverem ſubtiliſſimum redigatur ſuper porfidum; ita quòd pulvis ſit impalpabilis, qui ponatur in vaſe terreo bene cocto & bene vitreato. Et poſt ponatur ſuper dictum pulverem de aqua communi bulliente, movendo ſemper cum baculo mundo materiam, uſque materia fuerit ſpiſſa ſicut ſinapi. Et move dictam ſalſam cum baculo, quouſque videris apparere grana mercurii è corpore, & quod vobis appareat quantitas magna prædicti mercurii vivi, ſecundum quod poſueris de corpore perfecto, id eſt, de luna, & dum habueris magnam quantitatem, interim projice deſuper aquam bullientem; & tandem movendo, quoad tota materia reſolvatur in materiam ſimilem argento vivo vulgari, tollantur terreſtreitates cum aqua frigida, & deſiccetur per pannum: poſtea tranſeat per corium, & videbis mirabilia.* Lullius in Clavicula, Cap. 2.

Of the diſſimilitude of running mercury.

BEFORE I undertake to give you my opinion about your queſtion, I muſt crave leave to ſtate it ſomewhat more clearly, by propounding it thus: whether all the bodies, that in the ſhops, and among chymiſts, paſs for true running mercuries, are homogeneous; or ſo much of one and the ſame nature, that the ſeveral portions of ſuch mercuries are but numerically different? Now to the queſtion thus ſtated, the fear of ſeeming to maintain a paradox, by diſſenting from the generality of chymiſts, as well as naturaliſts, (who are wont to employ indiſcriminately all running mercuries not manifeſtly adulterated) will not keep me from returning a negative anſwer.

AND though it were not over difficult for me to give you the reaſons of my opinion, drawn up into method, and refer ſeveral inſtances I ſhall produce, ſome to the depuration of quickſilver, ſome to the impregnation of it, ſome to the coction, and others to two, or all theſe ways of altering it; yet I ſhall rather preſent you with them, by way of looſe obſervations, becauſe I preſume that freedom will not be unacceptable to you, as it will allow me, to give you ſome few, but uncommon notices and hints about ſuch noble ſubjects as prepared mercuries.

1. IN the firſt place, then, it may be obſerved, that a running mercury may be brought to differ from common quickſilver by depuration: for there are in moſt mercuries either recrementitious particles, or at leaſt ſome looſe adherencies, that are ſeparable from the reſt of the body; and which being ſeparated, the mercury becomes more homogeneous or clean, than it was before this external depuration, (for ſo I call it, to diſtinguiſh it from another, that is internal) that is uſually made, by grinding and waſhing mercury very well with ſalt and vinegar, (for which purpoſe, I alſo ſometimes uſe ſpirit of wine) which one may not unfrequently ſee ſomewhat fouled, by what it carries off from the mercury, which is alſo ſometimes attempted to be purified by the more laborious way of diſtillation; which, though in ſome caſes inſufficient, (as I ſhall ſhew anon) is in ſome others very convenient; whereto ſome artiſts add other probable means, tending to the ſame purpoſe. So that I do not wonder to find, that divers philoſophical Spagyriſts themſelves, before they proceed to more intimate preparations of mercury, order it to be ſeveral times previouſly incorporated and ſublimed with acid ſalts or ſulphurs, and then revived with alkalies. Since without examining their grounds it may be ſaid, according

to

to mechanical principles, that by diligent commixtures the mercury is divided into exceedingly minute, if not inviſible globules, or ſuch like parts; and by this great comminution, it acquires far more of ſurface than it had before, by which means a great multitude of ſeparable parts come to be touched, almoſt of every ſide, by the ſalts or ſulphurs, to which by this means, when the quickſilver is driven from them in the revivification, it is probable, that very many of them ſtick, that were not ſuperficial, when all theſe globules made up but one mercurial maſs. And it is poſſible too, that the alkalies employed to revive the quickſilver, may help to tear off from it ſome of the feculent particles, which the chymiſts would deſire to have it freed from. And here, let me advertiſe you upon the by, that there is no neceſſity to have recourſe to ſalt of tartar or quicklime, or ſuch like alkalies for the reviving of quickſilver: and therefore when I would, with eaſe, obtain a clean and active mercury for ſome purpoſes, I do not employ acid and then alcalizate ſalts, but mix very well common cinnabar finely powdered with a double weight, or at leaſt, an equal weight of filings of iron, or ſteel. For theſe being diſtilled together in a low retort with a ſmart fire, the ſulphur of the cinnabar will faſten upon the filings, and let the mercury come over fair and vivid, and perhaps ſomewhat impregnated with a martial vertue, upon whoſe ſcore it may be better, than if it had been prepared by mere depuration.

2. AND this leads me to the mention of another way of diverſifying mercury, which is by impregnation, either corporeal, or ſpiritual, (if for diſtinction ſake I may ſo call them.) But the impregnation being a comprehenſive way, divers particular methods may, after a manner, be referred to it: yet becauſe the true grounds of ſuch references are ſometimes hard enough to be aſſigned, at leaſt in few words, I ſhall allow my ſelf, without ſcrupulouſly regarding them, to proceed in my free obſervations.

3. THE next thing then, upon whoſe account a running mercury may come to differ from common quickſilver, is a ſpiritual impregnation. By mercury ſpiritually impregnated I mean that, with which ſome ſubtile parts of another body are ſo intimately aſſociated and united, that not only the additament will paſs with the mercury, when it is ſtrained through leather, (though that be the means, by which artiſts uſually ſeparate gold itſelf from the mercury, wherewith it has been amalgamed) but will alſo continue with it after diſtillation, without hindering the mercury from being vivid enough. I know there are many chymiſts, eſpecially among the more cautious, that look upon quickſilver as ſo heteroclite a mineral, that as no body can faſten enough upon it, to alter it intrinſecally, ſo it will not admit any other body to be aſſociated with it any thing intimately, or permanently. And indeed ſince we find, that when gold itſelf, with which of all bodies whatſoever mercury is believed to have the greateſt ſympathy, may yet be ſeparated from it by ſtraining an amalgam of thoſe two metals through leather, which will tranſmit the quickſilver, and retain the gold; and if ſuch an amalgam be diſtilled with a competent fire, the mercury will aſcend, and leave all the gold behind in the retort; ſince mercury I ſay, is ſo ſeparable from gold itſelf, it may ſeem improbable, that it ſhould be more intimately aſſociated with any other bodies. But theſe arguments, though ſpecious, do not, I confeſs, convince me, who muſt not deny, but that the corpuſcles of ſome mineral bodies may be ſo well commixt with quickſilver, as to paſs with it through the pores of leather, and who have found by trial purpoſely made (and elſewhere related) that quickſilver being in a convenient proportion amalgamed with tin, or with lead, and diſtilled with a competent fire, will manifeſtly bring over with it ſome of the aſſociated metal; inſomuch that not only I have found a notable increaſe in the weight of the diſtilled quickſilver, but it would both leave a tail, as they call it, behind it, when it moved upon a ſloping glaſs, and (which was more) when the ſluggiſh mercury had reſted a while, it would appear covered over with a kind of ſcum, made of the emerging corpuſcles of the tin, or lead, either of which, eſpecially the former, is a metal lighter in ſpecie than quickſilver. Hence it appears, that mercury may be ſo ſtrictly united to a not deſpicable proportion of a groſs and ponderous body, and of an ignobler kind, as to carry it along with itſelf in diſtillation; which by this appears not to be near ſo certain a way, as ſome learned chymiſts think it, to try, whether mercury be pure from all adulterating mixtures, and to free it from them, if it had any before. But the chief uſe I will make of this experiment is this, that ſince we ſee, that ſometimes mercury does not refuſe even corporal impregnations, (as for diſtinction ſake I call thoſe lately recited) it ought not to appear incredible, that it may in ſome caſes admit ſpiritual impregnations, and ſo intimately aſſociate with itſelf ſome of the finer parts of certain metals and minerals, as not to part with them, though they be diſtilled, and afterwards perhaps ſeveral times waſhed. This brings into my mind, that I had once a diſtilled mercury made by an impregnation of common mercury, a drop or globule of which, being evaporated from a thin piece of ſilver, not only ſeemed to have ſomewhat penetrated it, but (as I expected) left upon it a rugged ſubſtance apparently lighter than the ſurface of the piece, and of a colour very near that of gold, from whoſe nature perhaps it was not very remote: but that common mercury may indeed be ſpiritually impregnated, I have been perſuaded by divers effects, that I have tried of ſuch impregnations; and I acknowledge to you, that moſt of the uncommon mercuries, that I am now proceeding to tell you of, have been prepared after ſome ſuch manner.

4. ANOTHER thing, wherein a mercury may differ from common quickſilver, is a facility to amalgam with gold: for it is known to gilders, goldſmiths, and others, that are verſed in ſuch experiments, that to make amalgams with gold and mercury, it is uſual enough

to take ſix parts of the latter to one of the former, and ſome take eight or more. Nor is ſo great a proportion of mercury wont to keep them from thinking it requiſite to make both it and the gold ſeparably, and conſiderably hot to facilitate their commixture, but I have divers times had ſpiritually impregnated mercuries with but two parts, of which I would preſently make an amalgam with one part of the calx, or leaves of gold, and that without any other external heat, than that of the palm of my hand. Nay, ſometimes, for trial ſake, I have employed but one part of quickſilver to make in the palm of my hand a mixture, wherein the gold was ſo far from appearing, that the colour of the quickſilver was not ſenſibly ſo much as impaired.

5. ANOTHER difference between ſome mercuries and thoſe that are vulgar, is, that theſe being put to calx of gold, though one do at length bring them to mix, (for it is not ſo eaſily done, as men are wont to preſume) yet they will not diſcloſe any ſenſible heat, but the mixture, as each of the incorporated ingredients was, will to the touch be cold: but though I know there are many learned chymiſts, that look upon incaleſcent mercuries, that is, ſuch as will grow hot upon their mixing with gold, as chymical *non-entia*, or chimæra's, yet they are not competent judges of the poſſibility of things. For I have more than once, or a few times, both alone, and in the preſence of ſome curious perſons, found and evinced, that a diſtilled mercury may be ſo animated, that a ſingle dram of it, or perhaps a far leſs quantity, being mixed barely with my finger, with as much, or perchance half as much, calx of gold, would preſently conceive, not only a ſenſible, but a very conſiderable heat; inſomuch that ſometimes it would prove offenſive to the palm of my hand, wherein I made the mixture. Divers phænomena of this experiment may be ſeen in the author's little Tract *Of the Incaleſcence of Quickſilver with Gold*, now extant in the *Philoſophical Tranſactions*, *Numb.* 112. And I remember, that once being to convince a very eminent chymiſt, that there were ſuch mercuries, as I have been ſpeaking of, I took a remnant of a certain quickſilver, which I intend never to make again, (and of which, for the ſake of mankind, I reſolve not to teach the preparation) of whoſe diſpoſition to incaleſcence I had ſuch an opinion, that though we had no calx, nor ſo much as filings of gold, but only ſuch pieces, as he could groſsly prepare with a hammer and a pair of ſciſſors, I ventured to put my mercury to them in a glaſs-mortar; and yet notwithſtanding the thickneſs and cloſeneſs of the beaten metal, and the coldneſs of the veſſel, the mercury, to the artiſt's wonder, penetrated the gold, and grew manifeſtly hot with it. And this faculty of our quickſilver was not a tranſient and eaſily vaniſhing one; for I had already kept the mercury by me for ſeveral years. The incaleſcent mercuries hitherto mentioned were animated by tedious and laborious operations; but if I had deſired only to convince gain-ſayers, I could have done it by a very much ſhorter way: for though this ſort of impregnated mercuries be many degrees inferiour to the forementioned animated mercuries, yet as to incaleſcence with gold, I know by experience a way, which is indeed hard to hit, and requires a dexterous artiſt, but which, when it ſucceeds aright, will in an hour, and perhaps a leſs time, qualify mercury to grow preſently hot with gold.

6. WHEN an animated mercury is by due impregnation qualified to amalgam readily and intimately with gold, and penetrated ſo as preſently to grow hot with it, it is not much to be admired, that it ſhould alſo differ from common mercury, in the being able to carry up with it part of the gold, wherewith it was ſo ſtrictly aſſociated. I know, that many learned men, and among them divers chymiſts themſelves, do not think it credible, that at leaſt corporal gold ſhould be volatilized by quickſilver. And indeed that, which is common, may be many times diſtilled from gold, without carrying up any of it; but this ought not to conclude againſt ſuch ſpiritually impregnated mercuries, as I lately mentioned: for with a very ſmall quantity of one of them I have ſometimes elevated ſo much calx of gold, that the inſide and neck of the retort were richly gilt by the adherent particles of that metal, which would ſometimes ſtick ſo cloſe, as not to be without difficulty ſeparated from the glaſs. And I remember too, that having with one of theſe noble mercuries amalgamed about half its weight at moſt (if I miſtake not) of calx of gold, though it did not gild the inſide of the glaſs, yet I found, as I expected, that the diſtilled mercury was manifeſtly encreaſed in weight, as well as ſomewhat changed in colour and conſiſtence: which experiment may be added to thoſe, that I formerly mentioned, to prove, that quickſilver (duly prepared) may be corporally impregnated.

7. IN the amalgams made of one of theſe ſpiritually impregnated mercuries with calx of gold, I have ſometimes obſerved a thing, that argues ſuch mercuries to be differing from common quickſilver; of whoſe amalgams with gold ſuch an effect has never (that I know) been taken notice of. The phænomenon I mean was this; that by diſtilling one of thoſe ſubtile amalgams in a retort, a good part of the bottom of the veſſel, which I have yet by me, was left adorned with a very lovely colour, almoſt like that of turquois ſtone, inclining towards the colour of gold, and ſomewhat changeable; and alſo ſo cloſely faſtened to the glaſs, that it ſeems to have penetrated into it, though this beautiful ſtain were left by but a very ſmall quantity of the amalgam, and though this mixture were diſtilled but in a moderate fire, ſince it was in a ſand-furnace. Nor is this the only experiment of this kind, that I would alledge, ſince I elſewhere mention an amalgam of gold with an animated mercury, which being long decocted, when at length by an exceſſive fire unſkilfully adminiſtred the veſſel was unluckily broken, left the lower part of the glaſs permanently tinged with a pure and tranſparent red, that ſeemed to me to emulate that of a not common ruby.

8. ANOTHER

8. ANOTHER difference I found between ordinary quickſilver and ſpiritually impregnated mercuries, that will perhaps ſomewhat ſurprize you. And it is, that though one would expect, that amalgams made with mercuries ſo penetrant, and ſo diſpoſed to adhere cloſely to gold, ſhould make with it amalgams far more eaſy than thoſe made with ordinary quickſilver to be turned into red precipitate, yet I found the quite contrary upon trial. For whereas chymiſts are wont to mention about ſix weeks as the uſual time, wherein mercury may be precipitated even *per ſe*, that is, without additament, and allow but a ſhorter time to make this precipitation, when it is amalgamed with gold, (whereby ſome of it is detained, and all more expoſed to the action of the fire:) I have had the curioſity to keep an animated mercury amalgamed with about a third part of its weight of fine gold above twice ſix weeks, without having ſo much as a grain or two of precipitate (perhaps not half ſo much) that I could perceive, though the mercury grew hot with the gold at their being mingled, and though the mixture were purpoſely kept in a good heat capable to make quickſilver circulate. Nor did I content my ſelf with one trial, nor with one ſort of animated mercury, but in above five or ſix months I obtained not one grain (that I could diſcern) of precipitate, though the heat was ſo ſtrong, as to carry up many parts of the quickſilver, and of the gold with it, to the top of the glaſſes; nay, in one of them (which was a ſomewhat odd caſe) the fire was ſo violent, that the hermetically ſealed glaſſes beginning to melt, the ſpirituous matter included in it was ſo forcibly expanded, as to ſtretch the weaker ſide of the glaſs, and give it as it were a bunch, yet without breaking it; as I can ſhew you in the glaſs it ſelf, that I have yet entire by me. Nor do ſix months make the longeſt term, that the obſtinacy of my curioſity has made me keep gold in decoction with animated mercuries without obtaining a red powder or precipitate, though in the mean time there were produced very pretty vegetations, and ſometimes, which is far more conſiderable, odd changes of colours, about which it is not here neceſſary to entertain you; the main drift of this obſervation being to give you notice, that as far as I have yet tried, the more ſubtle and richly impregnated mercuries are far leſs apt to afford precipitates with gold, than common quickſilver is. As if that diſpoſition to be calcined, (as the chymiſts are pleaſed to ſpeak) or turned into powder, required the preſence of the recrementitious or more ſeparable part of quickſilver, that a chymiſt would perhaps call it ſulphur, which was a diſcovery I could willingly enough have miſſed. For I confeſs I had ſome hope, as well as intention, to try, whether a precipitate, made with gold and ſome of theſe noble and richly impregnated mercuries, would not prove a nobler medicine than precipitates made with gold, and only common mercury; though even of ſome of theſe, when dexterouſly prepared and kept their due time in decoction, experience invited me to have no ſlight opinion; eſpecially, if they be exhibited in a juſt doſe, and accompanied with a proper additament, by which they may be kept from raiſing any ſalivation, and have their operation either altogether or almoſt totally determined downwards.

9. THE laſt difference I ſhall obſerve between ſome diſtilled mercuries and common quickſilver, ſhall be their inequality in point of ſpecifick gravity. I know you will think this a paradox; but I can tell you, that I had once the opportunity to examine hydroſtatically a noble mercury, for the impregnating whereof neither corporal gold nor ſilver was employed; and yet having carefully weighed this quickſilver in water, according to the method I elſewhere teach, in the preſence of a famous and very heedful virtuoſo, I found it, as I had foretold, not only manifeſtly, but very conſiderably heavier in ſpecie (that is, bulk for bulk) than common quickſilver, though this mercury had been ſeveral times diſtilled, and by other ways depurated; which to me ſeemed to argue, that even ſpiritual or volatile gold (for no viſible gold was employed, and no metal but gold is ſo heavy as quickſilver) is able to increaſe the ſpecifick gravity of mercury it ſelf, which, of all the bodies we know, is exceeded or equalled in that quality but by one alone. And the ponderouſneſs of our lately mentioned mercury ſeems to me the more wonderful, becauſe having by the ſame method hydroſtatically examined a mercury, made after a ſtrange way, (without common mercury) I found it ſcarce at all to differ in gravity from common quickſilver, ſince it did not weigh full fourteeen times as much common water of the ſame bulk.

BUT here I ſhall obſerve to you upon the by, that it is not a certain conſequence, to infer, that the heavier the mercury is, the more fixt it muſt be; for I remember, that having been once ſo unadviſed as to comply with the earneſt ſolicitations of an inquiſitive gentleman, that afterward behaved himſelf very ungratefully and unworthily to me, I gave him inſtructions, how to make an animated mercury, which I looked upon as very much of the like nature to the ponderous one, I have been ſpeaking of, but leſs tedious, and far leſs difficult to be prepared; and while he found he needed my renewed directions, according as new difficulties occurred to him, he gave me from time to time an account of his progreſs; and when he was advanced far in the proceſs, he informed me, amongſt other things, that following my direction in purifying and animating his quickſilver, he found it ſo altered and ſubtilized, that he would diſtil it in leſs than half the time he had formerly employed to drive it over, with the like fire and veſſels.

THIS is what I thought fit to ſay at preſent, about the differences between common quickſilver and prepared (but yet running) mercuries. And yet I am content to add two or three advertiſements, for which, and eſpecially for the firſt of them, you will perhaps thank me, if ever you ſhould vigorouſly proſecute, in a ſpagyrical way, the more noble ſort of mercurial experiments.

In the first place then, I shall observe to you, that whatever some learned chymists, and others, teach to the contrary, it is matter of fact, that mercuries may be animated or spiritually impregnated by more ways than one, (not to say, by more than a few) so as to penetrate gold very powerfully, and grow hot with it; and it seems to me very probable, upon grounds not meerly notional, that the differing ways, that are employed to prepare these animated mercuries, by impregnating them with this, or that mineral, or metal, may much diversify their qualities and operations, according to the respective natures of the bodies they are impregnated with. Nay though there seem so great a distance between quicksilver and vegetable substances, yet I have seen a mercury, that was prepared by the help of vegetables without metals or minerals, which was very different from common quicksilver, by being more noble than it.

The second thing I am to acquaint you with, is, that as divers bodies and methods may be employed in the preparation of noble mercuries, (as I have newly observed,) so it seems very probable, that the common mercuries so prepared may have differing, as well as noble qualities and uses, not only in respect of alchymy, but of medicine; as being fitted to have potent operations, as well upon human bodies, as the more stubborn ones of metals and minerals. I am not indeed at all forward to recommend the needless use of mercurial medicines, of which we may too often see bad effects, if they be not as well prudently and cautiously given, as faithfully and skilfully prepared: but since we see, that, in spight of *Helmont*, very many learned and experienced physicians allow themselves to employ, frequently enough, even the vulgar preparations of common mercury, some of which prove indeed oftentimes in some stubborn diseases far more efficacious than ordinary medicines; I see not, why we may not hope for greater and more innocent effects from a mercury well purified and impregnated with the sulphur and finer parts of such bodies, as volatile gold, or Venus, or Mars, or antimony &c. And though, as I lately told you, I found such animated mercuries far more indispos'd than common quicksilver, to make a precipitate with corporal gold; yet this need not hinder, but that divers other preparations may be made, as well with impregnated, as with vulgar mercury; such as are turbith mineral, the white precipitate, that purges downwards, *mercurius dulcis*, pills of crude mercury made up with fit ingredients, (as in those, that are by some called the blue and the black pill) and especially the cinnabar made by subliming quicksilver and sulphur into a purely red substance, which, though wont to be employed chiefly by painters, ought not perhaps to be neglected by physicians; since even in ordinary cinnabar the vulgar mercury is so bridled by the common sulphur, that unless too frequently given without pauses, or in an indiscreet dose, it has not been usually found to salivate, yet does often lie not idle nor useless in the body: so that it may be well worth trying, whether a noble cinnabar may not be obtained by substituting animated mercury for vulgar, especially if instead of common sulphur one should employ that of antimony, or of antimony and vitriol, which I have elsewhere shewn to make.

The third and last advertisement I will give you, shall be, that you are not hastily to conclude, that a mercury, that has been carefully depurated and impregnated, has not been well prepared, if you find it not readily to elevate corporal gold, as it may seem by the past discourse, that most of the animated mercuries I have mentioned did. For though it be true, that I have had some mercuries fitted to penetrate gold so far, and mix with it so closely, that it would quickly upon distillation visibly carry up some of that ponderous metal with it; yet so much is not to be expected from all mercuries, that may lay claim to the title of animated or noble. For I have found, that some even of these may require a strong decoction to incorporate them intimately with gold; and I remember, that once, for trial-sake, I made mercury, which upon bare distillation would not at all colour the glass: I made, I say, this mercury, by decocting or circulating it with the gold for ten days or a fortnight, unite so closely with the metal, that it would afterwards elevate enough of it to gild the inside of the glass; and by a much longer decoction I have sometimes had the gold lodged copiously in the upper part, and even in the neck of considerably tall glass-eggs, hermetically sealed, one or two of which I can yet shew you.

OF THE

Producibleness of PHLEGM or WATER.

PART V.

Of the several substances, that chymists obtain by the fire from mixt bodies, that, which they call phlegm or water, and would have men look upon as mere water, separated by a preceding analysis, seems to the Helmontians, and divers other modern artists, to bid the fairest for the title of elementary and primordial. Wherefore it will now

now be fit to conſider, whether, about that alſo, we may not juſtly retain ſome doubts, and rationally ſuſpect, that all, that they call the phlegm of bodies, was not in the form of elementary ſimple water, pre-exiſtent in the body, whence it is obtained; but that even ſuch portions of matter, as many of thoſe, that paſs among chymiſts for phlegms, may be produced either by the operation of the fire, or by other ways.

IN order to this inquiry, it will be fit to premiſe ſomething againſt the preſumed ſimplicity and homogeneity of the liquors, whereto the Spagyriſts give, in common, the name of phlegm; that in caſe ſome of the produced liquors we ſpeak of ſhall be denied to be preciſely of an elementary nature, it may appear, that that ought not to hinder us from allowing them the name of phlegm, provided that they be not remoter from ſimplicity, than thoſe, to which chymiſts grant that appellation.

AND firſt, I conſider, that beſides thoſe qualities, that are common with water to divers other liquors confeſſedly not ſimple, as tranſparency, want of colour, aptneſs to be imbibed by moſt ſorts of vegetable and animal ſubſtances; the two qualities, upon whoſe account chymiſts are wont to call a body phlegm or water, are its appearing to them inſipid, and its being of a volatile and fugitive nature.

I FURTHER conſider, that not only divers of thoſe liquors, that paſs for phlegm, will yield a taſte ſenſible enough to him, that will hold them with attention of mind, for a competent time, in his mouth, but that the criterion of liquors by the taſte is nothing near ſo certain as many think. For, not to mention, that it is plain, that ſome kinds of dogs, as ſetters, ſpaniels, and blood-hounds, take notice of many things by their odours, that we men have no perception of by our ſmelling, which may argue, that our ſenſes may not be moved with objects, that would affect them, if they were of a more delicate contexture; not to mention this, I ſay, it is plain, that the ſubtlety of the ſenſe of taſting differs among men themſelves. And thoſe, that drink nothing but water, will often tell us of a great diſparity betwixt common water, wherein other men find not any. And I remember, that when once I did, though but for ſome months, confine my ſelf to drink water, I could diſtinguiſh the limpid waters of differing places, almoſt as manifeſtly as I now diſtinguiſh beers, which, after I fell again to drink wine and other liquors, I ceaſed to be able to do.

THE conſideration of quickſilver may, methinks, let us ſee, that it is poſſible for a groſs and fluid body, that is far from elementary water, to be inſipid. For quickſilver is without queſtion a fluid, and at leaſt in reference to ſome bodies, gold, ſilver, and ſome others, a liquor; ſince it ſoaks into their pores, and ſoftens the bodies. The ſame quickſilver may alſo ſerve to ſhew, by its diſpoſition to fly away in the fire, that volatility, even in conjunction with inſipidneſs, is no certain mark of an elementary or ſimple, nor conſequently of a primordial body. And indeed, ſince volatility depends mainly upon the extraordinary minuteneſs of the particles, whereof a body conſiſts, and on their being incoherent, and of ſhapes fitted for motion; this quality may be acquired by ſo many differing ways, and be found in bodies otherwiſe of ſuch differing natures, that unleſs it be found aſſociated with the other qualities proper to phlegm, it will be but an unſure argument, to prove the body, that it belongs to, to be elementary, and not to have been by compoſition, diviſion, or tranſpoſition produced.

IF it be true, as the Carteſians will have it, that water conſiſts of particles, that, like little eels, are long and extremely ſlender, and conſequently flexible; I ſee not any impoſſibility, that the various action of the fire, upon the minute parts of a body, and that, which it may cauſe the corpuſcles of one body to have upon thoſe of another, may produce water, that did not in the form of water pre-exiſt in the body, that affords it: for it ſeems to me poſſible enough, that the particles, whereof a corporeal maſs is made up, may have ſuch ſhapes, ſizes, and contextures, that by the various agitation, which the pervading corpuſcles of the fire may produce amongſt them, whatever edges and points they had before, may by mutual attrition of the corpuſcles be worn off, and by the ſame means ſo much of the ſubſtance may be worn away, that what remains, cannot but be very flexible, and by all theſe qualifications become fit to make a particle of water. As a bar of iron may, by divers ſtrokes of the wedge and hammer ſkilfully imployed, be divided into long and ſlender parts, whoſe edges and points being blunted, they may be reduced into ſlender, and every way flexible wires. But not to build on ſpeculations, let us proceed to ſome experiments, which afford phænomena, that ſeem favourable to our hypotheſis.

AMONGST the bodies, about which chymiſtry is converſant, thoſe, that ſeem to be the moſt indiſpoſed to be turned into water, are the metalline, and mineral ones: ſo that if it can be made appear, that any of this ſort can be changed into an aqueous liquor, it will make it highly probable, that aqueous liquors may be by chymical operations produced, eſpecially in vegetable and animal bodies; which ſeem far more ſuſceptible of ſuch a change, than the ſtubborn ſubjects of the mineral kingdom. And ſince quickſilver is by many learned men, as well chymiſts as others, looked upon as one of the few moſt indeſtructible bodies in nature, and by its great ponderouſneſs, in which it exceeds all the known bodies of the world ſave one, is ſo much the more remote from ſuch a liquor as water, that has not the ſixteenth part of its ſpecifick weight; if quickſilver itſelf can in great part be turned into an aqueous liquor, it will not a little favour the doctrine propoſed in theſe notes; for which reaſon I ſhall ſubjoin the enſuing ſtory.

RELATING to a very ingenious and ſober phyſician of my acquaintance what had befallen me in diſtilling mercury, from whence I once obtained a water without additament, without being

being able to make the like experiment afterwards ſucceed; he aſſured me, that he had a friend of his, had ſome years paſt provided a very large Dutch retort of good earth, furniſhed with a pipe of about a foot long, to caſt in the mercury at; and that having by little and little conveyed through that pipe a pound of quickſilver into the cadent retort, they obtained four ounces of water, and loſt in ſpite of their care two ounces of matter (whatever it were,) the remaining part of the pound having been elevated in the form of mercury. And when I ſuggeſted, that perhaps the water, that came over, was afforded by the aqueous particles of the earthen retort itſelf, he replied, that, to prevent their being impoſed on, they had been careful not to put on the receiver, till the retort had been made throughly glowing hot: and that this liquor was far from common water, he thought to be paſt doubt by that, which follows. For I having acquainted him with an odd trial or two, I had made with mercurial water, and aſked him, whether he found the like effects from his, he told me, that his friend and he poured both their diſtilled mercury and their water into a kind of China cup, and though it were in *June*, left it open in a garret for two or three days, upon a preſumption his friend had, that this mercurial water thus ordered would turn a good part of the quickſilver into its own nature, and ſo multiply itſelf upon it. But when they came to viſit their cup again, they were much ſurpriſed to find their water all gone, and that the greateſt part thereof was turned again into mercury; which they concluded from this, that they miſſed upon the balance but about half an ounce of the whole matter; which (half ounce) they ſuppoſed to have been loſt by evaporation; the other three ounces and a half being found in the increaſed weight of the mercury.

THE mention I have made of quickſilver, puts me in mind of an argument *ad hominem*, that may deſerve to be conſidered by the chief ſect of modern chymiſts, the Helmontians: for if it be true, which their maſter teaches, that by his liquor alkaheſt, not only quickſilver, but all other tangible bodies, may be reduced into inſipid water, juſt like rain water, I may be allowed to infer, that water may be produced, ſince ſalt and ſulphur themſelves may be turned into water. I know the Helmontians may anſwer, that this is not ſo much a production, as a reduction; ſince all things conſiſting originally of water, the alkaheſt does but deprive it of the diſguiſes, that ſeminal principles put it into, to make it appear, under the form of gold, quickſilver, plants, animals, *&c.* But this anſwer may be elſewhere further examined: for the preſent, it may perhaps be ſufficient to reply, that even by this anſwer it is granted to appear by experiment, that water has been copiouſly produced out of mineral bodies, but it has not yet been made appear, that thoſe bodies were produced out of water.

BUT this is not all, nor perhaps the principal thing I have to ſay in favour of the opinion pleaded for in theſe notes. For ſuppoſing bodies by being reduced, by the alkaheſt and the fire, into an inſipid liquor, were really deduced into water, yet the Helmontians would not fully ſatisfy me. For *Helmont* relates, that by abſtracting his immortal liquor from ſtones, or ſuch kinds of bodies, he turns them into ſalt equiponderant to the concrete; which ſalt by further operations he reduces, as he ſuppoſes, into elementary water. Since then he ſtops not at ſalt, but goes to a further tranſmutation, and concludes, that a ſtone doth not conſiſt of ſalt, becauſe that ſalt may, by further operations, be turned into inſipid water; he muſt give me leave, on the ſame ground, to argue, that inſipid water is not the firſt matter of bodies, ſince by a further operation of the fire, that liquor itſelf may be, at leaſt in great part, turned into earth. For I elſewhere relate ſome experiments of my own and a friend's, in which clear water, divers times very ſlowly diſtilled out of clear glaſs bodies, left every time a terreſtrial powder at the bottom: as if (in caſe water be ſo homogeneous a ſubſtance as is ſuppoſed) the whole body of the water might, by reiterated diſtillations, without violence of the fire, be reduced into earth; whereof I remember, in the laſt trial of mine, I had enough to cover the bottom of a large cucurbit, out of which the diſtillations had been made.

AND on this occaſion, I ſhall add a trial, which ſeems to argue, that without the help of often repeated diſtillations in tall cucurbits, clear water it ſelf may, by the operation of the fire, be changed into another body.

WE took, then, very pure and limpid water, which had, by our pneumatick engine, been carefully freed from the aërial particles, that are wont to be harboured in the pores of that liquor: this in a new bolt-head of ſuch a ſize, that the matter might have room to play and circulate, we ſealed up hermetically; and placing the veſſel in a digeſtive furnace, we left it there above a year, and obſerved, as we expected, that after it had continued for a good while, there began to form themſelves, in the water, little concretions heavier than it, which in proceſs of time increaſed in magnitude, and, as we thought, in number; making a kind of *terra foliata*, that conſiſted of a multitude of little thin films or ſcales, (like thoſe of the ſmaller ſort of fiſhes) which, when the glaſs was ſhaken in an enlightened place, were copiouſly diſperſed through the body of the liquor, and appeared variouſly and vividly coloured, being ſome of them almoſt as big as ſpangles, and more glittering: and when the agitation ceaſed, they preſently fell to the bottom, which they covered in the form of a *terra foliata*; by their ſubſidence manifeſting themſelves to be notably heavier, in ſpecie, than the water they had been formed of. And the longer the glaſs was kept in the digeſtive furnace, the more of this fine terreſtrial ſubſtance was produced: and leſt the effect ſhould be aſcribed to the abſtraction of the air from the water, handled as is before related, I ſhall add, that we produced the like ſubſtance, though, as it ſeemed, not ſo copiouſly, after the like manner, in water, that had not at all been freed from air.

OF

OF THE

PRODUCIBLENESS OF EARTH.

PART VI.

OF all the ſubſtances obtainable from mixt bodies, that which, to perſons not prepoſſeſſed with Helmontian opinions, may ſeem the moſt ſimple, elementary, and unchangeable, is that, which they call earth or *terra damnata*; becauſe there is ſuppoſed to be no doubt, but that the calcining or incinerating violence of the fire muſt not only have driven away the mercurial and other volatile parts, but muſt alſo have quite burnt out the ſulphurs, which oftentimes are more fixt than the reſt; as the water on the other ſide muſt have diſſolved away all the alkali or fixt ſalt.

THIS ratiocination, I confeſs, is very ſpecious and probable, but yet not ſo ſatisfactory, but that a ſceptick may retain not irrational doubts about the cogency of it, upon ſuch conſiderations, as I am now going to propoſe.

AND I will begin with conſidering, that, whereas the things, wherein this ſuppoſed ſimplicity, and unchangeableneſs of the earthy part of mixt bodies, is founded, are theſe three: its not diſſolving in water; its not affecting the taſte; and its not having flown away from the incinerated body, that afforded it; it may with probability be doubted, whether any of theſe, or all of them put together, do neceſſarily evince what chymiſts pretend they do.

AND in the firſt place, according to the different conſtitutions of certain ſorts of bodies, I think it fit to make a diſtinction between the dry and heavy parts, that remain after a body has been expoſed to the violence of the fire, and, if need be, freed from its ſalt, as much as it can be, by the affuſion of water. For it is evident, that in ſome bodies, eſpecially of a metalline nature, the fire, that makes that which they call calcination, does not operate as it does in the burning of vegetables. For, beſides that ſometimes almoſt (and ſometimes more than almoſt) the whole weight of a mineral is to be found in that which they call its calx, and is manifeſt in the calcination of lead and tin *per ſe* (if ſkilfully performed) the calx is in great part reducible ſometimes into a body of the ſame nature with that, which afforded it, and ſometimes into ſome other body, very far from being elementary: as is manifeſt partly in the reduction of minium, (which is calx of lead made *per ſe*) which, as to the greateſt part of it, we have more than once, by the bare way of ordering the fire, reduced in a very ſhort time, and without additaments, into malleable lead; and partly in the calces or (as they alſo ſpeak) aſhes of antimony, which by bare fuſion are eaſily reduced into glaſs, whence we have ſometimes obtained an antimonial regulus. So that it is manifeſt, that there is a great deal of difference, between the aſhes (taking that word in a large ſenſe) of metals, and of ſome minerals, where almoſt the whole body is by the fire converted into a dry and heavy powder, and the aſhes of incinerated vegetables, which uſually leave but a little quantity of earth behind them, in compariſon of the matter, which the violence of the fire hath driven away.

BUT ſetting aſide the above-mentioned metalline calces, which without queſtion remain compounded bodies, if metals themſelves be ſo; and to forbear examining, whether they be not further compounded with corpuſcles of the fire, or fuel, that are embodied with them: I conſider, that the qualities, which make other aſhes paſs for elementary earth, may be produced in portions of matter, that are not ſimple, either by compoſition or change of texture.

I HAVE elſewhere occaſion to take notice of bodies, which, though, when they are ſingle, they will eaſily diſſolve in water, yet the reſult of them will not: and you may find inſtances of this kind, among the magiſteries, as chymiſts call them, made of ſeveral bodies, by precipitating their ſolutions (made in acid liquors) with oil of tartar *per deliquium*.

FROM oil of vitriol and ſpirit of wine, though both moſt readily diſſoluble in water, we have, by bare digeſtion and diſtillation, obtained a pretty quantity of a ſubſtance, that we found not to diſſolve in water, and which ſeemed to be inſipid and fixt enough.

THERE are ſtones, ſome more and ſome leſs precious, which though I could by the help of the fire deprive of their colour, and bring to a white powder; yet it did not appear to me, that they were really calcined, or would in water yield any ſalt: ſo that if theſe ſtones be compounded bodies, as Spagyriſts tell us they are, we ſee, that there may be other corpuſcles beſides metalline ones, which though reduced by the help of the fire to a white powder, inſipid, and not diſſoluble in water, are yet remote enough from an elementary nature.

BUT I need ſeek no further, for inſtances of this kind, ſince Spagyriſts themſelves teach us, that the aſhes of wood may, by the violence of the fire, be turned into glaſs; which being a body compoſed of the earthy and ſaline part of the aſhes, (for they tell us, that earth ſeparated from the ſalt will never be vitrified) muſt be according to their own confeſſion a compounded body: which being at laſt made by the utmoſt violence of the fire, muſt be fixed, indiſſoluble in water, and conſequently inſipid. And without taking this vitrification upon the chymiſts authority, it is manifeſt, that in glaſs made the common way, there is a great deal of borellia, ſal alkali, or other lixiviate ſalt mixt with the ſand: as is evident, not only becauſe artificers find the ſalt needful to diſſolve

the

the ſand, and bring it to fuſion, but becauſe the glaſs uſes to weigh very much more, ſometimes (as an ingenious maſter of a glaſs-houſe anſwered me) thirty, or forty pound in an hundred, than the ſand, that was put in.

I SHALL add, that, ſince chymiſts aſcribe all odours to ſulphur, I may reaſonably conclude againſt them, that in ſpite of all the violent fire, which is required to the making common glaſs, there is ſtore of ſulphur, as well as ſalt in it. For I have often tried, that by barely rubbing two large pieces of glaſs, one againſt another, there would quickly be produced a ſtrong offenſive ſmell. And yet glaſs, which thus appears to be, not only a compounded, but a decompounded body, ſince the ſand or cugali (as the Venetian glaſs-men call their pebbles) or other ſtones being themſelves mixt bodies, are further compounded with the ſalts that diſſolve them: glaſs, I ſay, is a body, that manifeſtly poſſeſſes all theſe three qualities, which chymiſts require in their earth, being taſteleſs, indiſſoluble in the water, and fixed in the fire. And if aſhes alone be (as chymiſts teach us they are) capable of vitrification, (and indeed an inquiſitive owner of a glaſs-houſe anſwered me, that once, if he much miſ-remembered not, made, but not eaſily, glaſs of aſhes alone without ſand;) how are we ſure, but that in common aſhes, freed the common way, from their fixt ſalt, that which is called the ſimple earth, may not be a body compounded of two or more ſubſtances, which by their coalition, and new texture produced by the action of the fire, have been brought to a kind of vitrification, or otherwiſe have acquired the few obvious qualities, that chymiſts are wont to think ſufficient to give a production of the fire, the name of earth?

IT is obvious to obſerve, that divers bodies, when they come to be of ſenſible bulk, will ſink in liquors, in which their corpuſcles would freely ſwim, if ſo many of them did not ſtick together. As of ſalt and ſugar, the lumps, and even the grains, whilſt they remain ſuch, will fall to the bottom of water, in which when they are diſperſed into minute and inviſible corpuſcles, they will eaſily ſwim. And I have obſerved, that in ſtopt glaſſes ſome ſalts, and other bodies, that for many months remained undiſtinguiſhed in the liquors, that harboured them, would in tract of time have conventions made of their particles, that would then ſubſide, and be no more carried up and down by the particles of the liquor. And I ſee no impoſſibility, that ſomewhat of this kind may happen to the particles, whereof water conſiſts: for if ſome of theſe, by frequent occurſions and attritions come to apply themſelves to one another, ſo as to have a fuller, and more immediate contact than formerly, and to be intangled among themſelves, and perhaps alſo to exclude ſome very thin and ſubtile air, that may be ſuſpected to lurk about them, and contribute to their ſuſtentation; if, I ſay, this union, or ſtrict adheſion of aqueous corpuſcles, ſhall happen to be made, the aggregates or cluſters, though as to ſenſe but very ſmall, may be too great and unwieldy to be any longer parts of water, but may ſubſide in that liquor; and if their union or adheſion be ſtrict enough, they will upon the ſame account be unfit to be carried up in the form of vapours, and exhalations by heat, and ſo may be like earth fixed in the fire, as well as not diſſoluble in water.

I HAVE ſometimes alſo had a ſuſpicion, that the production of an earthy ſubſtance in water may be furthered by the particles of fire, that are employed to make it circulate; and that of thoſe igneous particles, which, as I am apt to think, pervade the glaſs, ſome of the groſſer, or rather the leſs ſubtile, may in their paſſage faſten themſelves to ſome aqueous particles, fitted to adhere to them, and may with theſe begin to make ſome inviſible concretions; to which afterwards, other congruous particles may, little by little ſtick, in their paſſage, and ſo at length compoſe ſenſible aggregates of powder: which may be illuſtrated by what happens in the precipitation of quickſilver without addition, where the mercurial particles being aſſociated by, and probably with ſome of thoſe of the fire, begin to form concretions, at firſt very minute, which afterwards increaſe more and more, by the acceſſion of other adhering particles, till all the mercury, or the greateſt part of it be reduced, from a fluid body, to a red powder. And perhaps it may countenance my conjecture, about the production of an earthy ſubſtance, by a briſk concurrence of the particles of fire, if I add, that though I have kept high rectified ſpirit of wine for above a year together hermetically ſealed, and for the moſt part of that time in a digeſtive furnace, without finding any earthy reſidence; yet, when I ordered a bolt-head, that, though it were hermetically ſealed, the alcohol of wine that was put into it might be boiled without breaking the glaſs, I found, that in a ſhort time this liquor would afford a not inconſiderable quantity of ſuch a ſubſiding talcky ſubſtance, as I obtained from the water formerly mentioned. But theſe things I need propoſe, but as illuſtrations, that may ſomewhat help you, to conceive how water may be turned into earth. For, whether it be by theſe, or any other ways, that the thing is performed, yet ſince the experiment formerly recited, that water by frequent cohobations may be more and more turned into earth, argues the matter of fact, our not being able to explicate the manner, does not hinder the thing from being true, nor the argument we build on it from being good: ſince even water, to which, by ſome operations of the fire and the alkaheſt, it is pleaded, that bodies are ultimately reduced, may it ſelf by a further and very ſimple operation of the fire be reduced into earth.

I HAVE ſomewhere mentioned, for I remember not in what paper I have obſerved, ſalt-petre diſtilled with clay, to loſe much more of its weight, than can be ſuppoſed to have aſcended in the form either of ſpirit or phlegm. And now to make this experiment more ſhort and eaſy, I ſhall add, that I lately made it in a crucible, (inſtead of a retort) wherein a double weight of finely powdered tobacco-pipe clay,

very

very well mixt with pulverized cryſtals of nitre, were kept three hours, in a violent fire, and then the mixture being taken out, the remaining fixt ſalt was carefully extracted, but amounted to very little in compariſon of what nitre was wont to yield, when calcined with charcoal. And that this ſcant proportion of fixt ſalt did not proceed chiefly from a very copious avolation of nitrous ſubſtance, appeared probable by this, that the *caput mortuum* was much more ponderous, than was to be expected, upon the ſcore of the tobacco-pipe clay, that was firſt employed, and the alkali, that was extracted; ſo that the new weight acquired by the clay ſeemed manifeſtly to proceed from the acceſſion of a portion of the ſalt-petre, that by this operation was turned into earth. Inſomuch, that of ſix drachms, that four ounces of clay had acquired in weight, after the crucible was taken out, not ſo many grains could even by boiling water be obtained from the whole *caput mortuum*; which, when firſt taken out of the crucible, was almoſt quite inſipid.

THAT earth may be *de novo* produced, may likewiſe be probably argued from the experiment I formerly related about the deſtruction of the ſalt of tartar, by igniting it, and putting it into fair water; for there remained after the numerous filtrations, and, if I miſremember not, after every one of them, a ſubſtance in the filter, which, for aught appears, may be as well called earth, as that, which was ſeparated from the calcined tartar, the firſt time it was put in the water, to divide the ſalt from the earth. For in our experiment, as well as in the common operation I come from mentioning, the way of proceeding is the ſame, and in both there remains in the filter a ſubſtance, which, by its ſtaying there, ſhews it was not diſſoluble in the water, and which before it came thither, ſhewed, by its enduring a violent fire, that it was alſo fixt as earth ought to be. Nor would it much move me, if it ſhould be found, that this factitious earth may have ſome ſuch operation upon ſome particular body, as is not thought to belong to true elementary earth. For ſince it is obtained by a chymical analyſis, if it have thoſe qualities, that in the general eſtimations of naturaliſts make up the notion of what they call earth; I think that ought to ſuffice us, at leaſt till the chymiſts give us ſome accurate notion of genuine earth, and ſhew us ſuch a thing, and teach us a better way of analyſis, to obtain it.

FOR in many bodies, that are, without ſcruple, looked upon as earth, I obſerve qualities, that do belong to the received notion of elementary earth. This I ſay, becauſe I ſee not, why ſuch a texture, as will ſuffice to make a portion of matter indiſſoluble in water, fixt in the fire, and inſipid upon the tongue, may not alſo make it fit to operate actively upon ſome bodies, and modify the operations of ſome others, that act upon it. And if our earth from ſalt of tartar be rejected as ſpurious, they ought to confeſs the inſufficiency of their common way of ſeparating a true earth from the bodies they analyze: for it ſeems calcination, and ſolution in water, and filtration, which make up their uſual method, will not ſuffice to make our earth of tartar paſs for true; though it appear not to be near ſo remote from an elementary nature, as ſome other bodies, that are obtained from earth by the vulgar analyſis. Of which I ſhall at the cloſe of theſe notes give an inſtance, in well-dulcified quick-lime, which, according to the doctrine of the chymiſts, ought to be an elementary earth; and yet ſeems not more ſo, (if it be ſo much,) as our earth from ſalt of tartar. And for the preſent, I ſhall add, that the *caput mortuum* of vitriol remaining after it had long endured a violent fire, though it were diligently freed from ſaltneſs by reiterated ablutions with hot water, was yet far from being an elementary earth; as appeareth not only by its deep purpliſh colour, and its ponderouſneſs, far exceeding that of earth, but by a trial, that I purpoſely made to examine it.

UPON this occaſion I remember, that a learned man of my acquaintance, who viſited the mines of *Hungary* (and dealt much in Hungarian vitriol) affirmed to me, when I told him I conceived the *caput mortuum* of it to retain much of the metalline nature, that he had, upon a certain occaſion, out of the colcothar of a certain ſort of Hungarian vitriol, not only received a pretty deal of good copper, but ſeparated from that copper a pretty portion of ſilver, and ſome grains of true gold.

BEFORE I put a period to theſe notes about earth, though my argument do not need nor require, that I ſhould do it, yet upon this fair occaſion I ſhall here take leave to doubt, whether ſuch an elementary earth, as the ſchools tell us of, do yet appear to be more than a notional thing. For to what I have already ſaid concerning the earths ſuppoſed to be produced by chymical analyſes, I ſhall now add, that I have not yet ſeen it proved, that nature does, any more than art, afford us a true elementary earth; at leaſt I can ſay, that ſome, which ſeem to be of the more ſimple ſort, I found upon examination to have qualities not aſcribed to pure earth. For though tobacco-pipe clay, by reaſon of its fixity, whiteneſs, and inſipidneſs, and its lying oftentimes deep enough beneath the ſurface of the ground, may, as probably as almoſt any other native earth we know, be looked upon as elementary; yet tobacco-pipes well baked may ſometimes be made to ſtrike fire. And I have more than once tried, that by briſkly rubbing two pieces of a new tobacco-pipe, one againſt another, they would in a minute or two of an hour grow warm; and being immediately ſmelt to, manifeſtly afford a rank odour, between ſulphureous and bituminous, almoſt like that, which proceeds from pebbles or flints, when they are likewiſe rubbed hard againſt one another. As if tobacco-pipe clay were not a true earth, but a fine white ſand, conſiſting of grains too ſmall to be diſtinctly taken notice of, like thoſe of other ſand. On which occaſion I ſhall add, that I found, by a hydroſtatical trial, that its ſpecifick gravity was but little differing from that of pebbles, its proportion in weight to water of the ſame bulk being as two and a quarter to one. A tobacco-pipe may alſo be ſome-

what melted by a very vehement fire, (for a leſs will ſcarce ſerve the turn) as may be argued from this, that it may by ſuch a fire be brought to bend.

PORCELLANE, or the matter, whereof China diſhes are made, is not, as ſome travellers and learned men have fondly imagined, a compoſition, that requires to be buried under ground, for I know not how many years, to ripen it into porcellane: but as ſome late authors inform us, and as I have been aſſured by a perſon, that went purpoſely to that place in *China*, that is ſo famous for the making of porcellane veſſels, it is a pure ſort of clay; but yet this I find not to be elementary earth. For beſides that I have obſerved, that a violent fire will make it ſomewhat melt; I find, that with ſteel it will eaſily enough ſtrike fire almoſt like a flint. The like I have obſerved in porcellane very artificially imitated with a ſort of Engliſh clay. And I found too, that the matter even of dark-coloured jugs of the better ſort, and well baked, would with a ſteel afford ſparks of fire. I forgot to tell you, when I was ſpeaking of fine porcellane, that I found its ſpecifick gravity to be very near the ſame with that of flints, and tobacco-pipe clay. But I remember I went once to viſit a grove or pit, where at the depth of divers yards, they were wont to dig up a certain white earth, which diſtilled, by an acquaintance of mine, afforded a liquor, that was put into my hand to try, and which I found to be very rich in a volatile ſalt, that taſted and ſmelt much like ſpirit of urine, or hartſhorn, and had almoſt the ſame effects in changing the colours of ſome bodies, and precipitating of others. I remember too, that I found by the operation of a menſtruum or two upon tripoli, that, as white and pure a virgin earth as it ſeemed, yet it was not elementary: and, on the other ſide, a maſter of ſome Engliſh mines having preſented me, among other minerals, which he knew not what to make of, a very white ſubſtance, whereof he had ſtore, which he thought an earth, and which was judged by an excellent artificer, much converſant with tripoli, to be finer even than that earth, I gueſſed it upon examination to be a kind of talc, whoſe leaves were exceeding fine and minute. The reſult of theſe relations may be, not only, that we may yet retain our doubts, whether the aſſertors of elementary earth can ſhew us any native ſubſtance, that deſerves that name; but alſo, whether thoſe things, that remain after chymical analyſes, though they have all the qualities, that are judged ſufficient to denominate a portion of matter, earth, may not yet either be compounded bodies, or be endowed with qualities, which belong not to ſimple earth. To explain and confirm which, I ſhall give an inſtance in ſome quick-lime, that I purpoſely examined. For though it had been, by frequent ablutions in warm water, carefully dulcified, and ſo was as well inſipid, as fixt, and indiſſoluble in water; yet I found, I could readily diſſolve it in divers menſtruums, and even ſpirit of vinegar: whereas true elementary earth ought to be as well indiſſoluble in ſuch liquors as in water.

IF I had not been to deal with chymiſts, but Ariſtotelians, I might have ſaved my ſelf the labour of ſolicitouſly endeavouring to prove, that earth and water may each of them be produced from bodies of a differing nature from it. For though the Peripateticks will not allow the whole elements to have been produced, becauſe they look upon them as integrant parts of the world, which *Ariſtotle* laborioufly (though not ſolidly) maintains to be eternal; yet the portions of the elements they will have to be interchangeably tranſmutable. So that what was once water may be earth, and earth may, by intermediate alterations, be turned into water.

BUT thoſe I have to do with, being the vulgar chymiſts, who will have the material principles or ſimple ingredients of mixt bodies co-eval with the world, and uncapable of being either deſtroyed or produced; it was not allowable for me to proceed upon the Ariſtotelian hypotheſis, of the tranſmutableneſs of what they call elements; eſpecially becauſe, that though I do admit it, as it is, according to my opinion, a part of a more general truth; yet I do not think, they have well proved it by their arguments: which ſince I my ſelf do not like, I think it were diſ-ingenuous to preſs them upon others. And without having recourſe to their doctrine, there will occur ſome other particulars, that may be added to thoſe already mentioned, to countenance the producibleneſs of the principles of mixt bodies, in ſome other papers, that are to follow theſe notes; though in ſtrictneſs I was not obliged to ſay ſo much, as I have already ſaid, ſince pretending to call in queſtion no more than the three hypoſtatical principles of the chymiſts, I might eaſily have excuſed my ſelf for having let alone the production of water and earth; ſince the generality of chymiſts reckon not thoſe bodies amongſt their hypoſtatical principles, but look upon them, as receptacles, or, as others would have them, recrements of theſe, or, as on ſome other account, related to them. But I was not willing to omit water and earth, becauſe ſome of the more learned of the modern Spagyriſts have adopted them into the number of the principles of mixt bodies; and becauſe I find by experience, that in chymical analyſes they are at leaſt as often to be met with, as ſome of the principles confeſſedly hypoſtatical. But what has been delivered about earth and water having much added to the bulk of theſe notes, it is time I ſhould put a period to this part of them, in reference to which I hope it will be conſidered, that I do not pretend, that every ſingle experiment by me alledged does ſufficiently prove, that the body obtained by it was in the ſtricteſt ſenſe produced. For if the ſeveral experiments, and other proofs, do in conjunction, and, as it were in a body, make up a good argument, that the ingredients they relate to, may be produced; it is as much as will, I hope, be expected from theſe notes, which having been written by way of appendix to the *Sceptical Chymiſt*, may be allowed, as well as that book, to employ ſome proofs, not altogether cogent,

and

and may be judged not improper, though ſome of the arguments propoſed in them, to ſhew, that chymical principles are not all ingenerable and indeſtructible, ſhould be but meerly probable. And yet this I ſhall venture to intimate, that vulgar chymiſts and Ariſtotelians may not, perchance, find it ſo eaſy a thing, as it is like many of them will imagine, to confute divers paſſages of the foregoing tract; ſince probably their objections will ſuppoſe ſomething or other, which, though taken for granted among them, and perhaps by ſeveral other learned men, I do not admit as true, or think demonſtrable, but rather queſtionable, upon very rational grounds. And though perhaps I ſhould not have brought in ſome of the experiments mentioned in the preceding notes, if I had not had a mind to throw together what I thought might contribute to ſo uſeful a thing, as a natural hiſtory of chymical principles, on which others, if not I, may hereafter ground a theory of them; yet this may alſo deſerve to be conſidered, that if any of the foregoing experiments, though never ſo few, do really prove, (as it is like ſome of them will be judged to do) that any one of the chymical principles may be, *de novo*, produced; that alone will ſuffice to deſtroy the univerſality and intireneſs of their hypotheſis; and beſides give cauſe to ſuſpect, that by further induſtry, the producibleneſs of other principles alſo may be diſcovered.

SOME

SOME CONSIDERATIONS

Touching the

Uſefulneſs of Experimental Natural PHILOSOPHY.

Propoſed in a familiar DISCOURSE to a FRIEND, by way of Invitation to the Study of it.

The Publiſher to the Reader.

IT is, courteous reader, part of the ſatire of *Petronius* againſt the vice of his own time; *Priſcis temporibus, cum adhuc nuda Virtus placeret, vigebant artes ingenuæ, ſummumque certamen inter homines erat, ne quid profuturum ſæculis diu lateret. Democritus omnium herbarum ſuccos expreſſit, & ne lapidum virgultorumque vis lateret, ætatem inter experimenta conſumpſit.* Other examples of the like induſtry he brings, and then concludes againſt the lazineſs and luxury of his own age: *At nos*, ſaith he, *ne paratas quidem artes audemus cognoſcere, ſed accuſatores antiquitatis vitia tantùm docemus & diſcimus.* It was for want of a *Democritus* or two, that he caſts this hard cenſure upon his own time. For notwithſtanding all his harangue in commendation of ſome ages, which were antient to his own, it is evident out of hiſtory, that there was never at once any great number, who ſeriouſly and in earneſt for the benefit of mankind applied themſelves to theſe ſevere ſcrutinies of natural bodies. It is true, that now and then, in all centuries from the beginning of the world, there have appeared ſome perſons of a nature more refined, as if indeed (according to that fancy of the old poets) ſome *Prometheus* had made them either of another metal, or of another temper, from the vulgar, utterly above all mixture with, or embaſement by the common faſhions of this world; who did make it the end of their lives, by ſevering and mixing, making and marring, and multiplying variety of experiments on all bodies, to diſcover their hidden virtues, and ſo to enlarge the power and empire of man. But theſe were ever very few and ſingular. Even in that ſo much celebrated time of *Democritus*, theſe ſtudies were ſo rare, that his uſual exerciſe of the anatomy of beaſts was looked upon as that, which made the ſoundneſs of his mind queſtionable, even as a ſpice of madneſs in him: and probably much more might the vulgar of his age have been amuſed, had they ſeen him torturing minerals and metals in the more toilſome anatomy of fire.

NOW if it be a diſhonourable crimination to an age, that it hath brought out no perſons who make it their great endeavour *Ne quid profuturum ſæculis lateat*; and if the diſcovery of one or two perſons of this kind be enough to expiate for, and take off the diſhonour of the proletarian lazineſs and luxury of the reſt; I think I may juſtly eſteem, that the exhibiting to the world the hiſtory of the ſtudies of the honourable author of this piece, may ſerve to be the apology and defence of our age, againſt ſuch cenſures, as that, wherewith the newly cited ſatiriſt ſtained his own time.

AND this was one great reaſon, that hath made me very forward to promote the publication of this, and divers other writings of the ſame noble author. For were there only tokens of endeavour in them, the proof of this endeavour (even without attainment) ought to wipe off all imputations of this nature. But this motive (though I do account, that by exhibiting this expiation I do ſomewhat oblige the age, whoſe honour is thereby defended, yet) was far from being the moſt great and forcible. For the excellence of the works themſelves, even as ſoon as they fell from the pen of the author, did long ſince in all equity ſet an Imprimatur on them:

Nec ſumunt aut ponunt ſecures
Arbitrio popularis auræ.

Epicurus, when he was caſting up the account of his life, upon the very day of his death, mentions a very great pleaſure, that he even then took in two parts of his former ſtudies; and theſe were his *Rationes*, and his *Inventa*; points well argued, and things happily found out. The two very ſame particulars are principally conſpicuous in this enſuing piece. There are good concluſions againſt the enemies of the being and providence of God in the firſt part, and in the ſecond there be notices of divers *Inventa* profitable to the uſe of man. By the one, ſound notions are propoſed to the reader's apprehenſion from the contemplation of God's creation and government of the world, and thereby good matter is ſuggeſted to his affections for the advancement of his devotion: by the other, there are divers things delivered, which may tend to enlarge man's power of doing good: by them, in the whole, both our honour to God, and our charity to our neighbours may be aſſiſted; in which two, the ſubſtantial part of all the moſt noble, not only human, but Chriſtian virtues, both ſpeculative and practical, are certainly contained.

I MUST not omit, that an argument of this nature, at this time, may juſtly be commended for its ſeaſonableneſs, when divers perſons, who know not the way of experimental philoſophy, and are loth now to give themſelves the trouble of learning it, have been making ſome attempts, very unthankfully, to traduce both it and its promoters.

THESE conſiderations paſſed with me for reaſons, and had upon me this force and prevalence, that as ſoon as I had the author's leave, I durſt not forbear the committing of them to the preſs, notwithſtanding his many arguments, which were plauſible enough to the contrary; as, namely, that much of the firſt part was written, when he was of ſo immature years, that ſhould I be particular concerning his age then, to any perſon, who hath read the piece, the paucity of ſuch inſtances might juſtly make me deſpair of begetting credit to my relation. Another objection was, that though his method did of neceſſity lead him to it, yet it might be looked upon as unbecoming for him to meddle with the phyſician's art, of which he never did, (nor could, by reaſon of his native honour) make any profeſſion. But theſe oppoſitions being raiſed upon points of curioſity in ceremony and outward decorum, were of little weight, when the forementioned noble offices of charity and doing good were in the other ſcale.

THE greater queſtion was; Suppoſe them to be publiſhed, but why now? why ſo ſoon? ſhould not rather the edition have been delayed, until it might have come out together with the ſecond ſection of the ſecond part? (which diſcovers the uſe, that may be made of experimental learning, to advance the empire of man over other creatures) or until the common preface, and ſome other little tracts, all written long ſince, and intended to accompany this, might be reviſed by the author; or at leaſt until the author might have had leiſure to have made ſome more new and full animadverſions to the receipts and proceſſes contained in the appendix? The conſideration, which anſwered this objection, was, that this piece, as now printed alone, would make (as you ſee it doth) a very competent book, which would have by itſelf the perfection, if not of the whole, yet of a more principal part; and of that part, which to profeſſors or candidates of learning is moſt deſireable. And then the author's avocations and other ſtudies being ſo many, that we could prefix no certain time for the complement of the mentioned remaining parts, I was loth to hazard the preſervation of theſe, by deferring the impreſſion; ſince I know there is no ſecurity of the continuance of thoſe writings, which are repoſed only in ſingle, or at moſt in few written copies. I remember, the author had once loſt for a good while one of theſe very eſſays, which are now here printed, and put beyond that danger for the future. Beſides other caſual accidents, the very contingency of human life, and the chance of a man's papers after death, (for to them the queſtion of king *Solomon* is moſt proper and pertinent, *Who knows, whether then they may happen to fall into the hands of a wiſe man or a fool?*) were of force enough to perſuade me to ſecure theſe, when it was in my power, unto the common uſe. Would not printing in all probability have preſerved unto us that univerſal hiſtory of vegetables from the cedar of *Lebanus*, unto the moſs, that groweth upon the wall, written by that wiſe and learned king, and the loſs of which we now in vain lament? Would not printing have ſaved that excellent book of *Democritus*, which he inſcribed his XEIPOΓXMHTA, or experiments of his own perſonal trial, ſo utterly loſt, that the name of the piece is not mentioned among the catalogue of his writings in *Laertius?* And may not the printing of this piece be a means of the preſervation (beſides the notional part) of divers very uſeful XEIPOΓKMHTA of the honourable author? who hath been ever unwearied in the trial of all probable experiments, that may increaſe the light, or advance the profit of mankind, and whom I may now name to be that moſt learned and noble perſon Mr. *Boyle:* for the ceaſing of certain conſiderations, that before made him willing to have his name ſuppreſt, and the general very good acceptance of this diſcourſe, have extorted from his honour, that he no longer conceal himſelf to be the author.

BUT before I leave the reader, I muſt give him this ſingle advertiſement, that the paſſages included within the paratheſes or crochets, as the preſs ſtyles them, that is, between any two ſuch marks as theſe [ ] were inſerted long ſince the writing of theſe eſſays, upon the relection of ſome parts of the book before he ſent it to me: which I therefore did ſo diſtinguiſh, and do intimate, that there may appear no inconſiſtency in our author, and the reader may not marvel to find ſome things very recent in a book written ſeveral years ago. Farewell.

RO. SHARROCK.

The Author's Advertiſement about the following Eſſays.

THAT the title of the following treatiſe might not raiſe in the reader an expectation of more than he will find in the book, I think myſelf obliged to inform him, that, though it come not forth before, divers parts were ſent to the preſs in 1660, or 1661, and this preſent year 1663; yet the very laſt eſſay of it was written divers years before: ſince when thoſe papers were left, ſometimes in the hands of friends, and ſometimes in diſtant places, where I could not come at them: which I mention, that the reader may neither wonder

nor blame me, if he now meet with ſome things in them, that have already been publiſhed by others, or are more vulgarly known, than my way of mentioning them implies. For it may, this notwithſtanding, very well be, that when I writ them, no body had yet lighted on ſome of them, and that others of them did then but begin to be taken notice of. And as for the five firſt eſſays, which treat of the uſefulneſs of natural philoſophy to the mind of man, though by my addreſſing them all the way to the gentleman I call *Pyrophilus*, they may ſeem to have been originally written to the ſame perſon, and about the ſame time with the eſſays, that make up the ſecond part; yet indeed a great portion of the firſt part was written, as I remember, 10 or 12 years ago, (when I was ſcarce above 21 or 22 years old) to another friend, to whom the conſiderations, that ſerved to confirm piety, and excite devotion, were far more acceptable than thoſe, that were more purely phyſiological. So that having, whether through lazineſs, or want of leiſure, contented myſelf to ſubſtitute the name of *Pyrophilus* for that of my other friend (who was not unwilling I ſhould do ſo) in a diſcourſe written, when I was ſo young, I would not have the reader think, that I do now ſo approve of all thoſe youthful diſcourſes (which I therefore ſuffer to paſs abroad without a name) as to think all the tenets they propoſed to be irrefragable truths, or all the reaſonings they contain, to be demonſtrative; and that I would at preſent have my judgment eſtimated according to their cogency. But yet I do, without much reluctancy, comply with thoſe friends, who would by no means conſent, that the five firſt eſſays of this treatiſe ſhould not come forth with the reſt; partly becauſe not writing all things for all readers, I hold it not unfit to publiſh ſomething to gratify thoſe, who deſire with me, to be both excited and aſſiſted to admire and praiſe the great and wiſe Author of all things; partly becauſe the treatiſe would ſeem maimed and incompleat, if the latter eſſays ſhould come abroad without the reſt; and partly too, becauſe learned men have been pleaſed to aſſure me, that thoſe eſſays are not deſtitute of notions and ratiocinations, that are not altogether vulgar or contemptible. However thoſe readers, that either cannot reliſh, or at leaſt deſire not any thing, but what is merely phyſiological, may, thus advertiſed, paſs by the former part of this treatiſe, and content themſelves to read over the latter; though they, who ſhall take the pains to read both, will not perhaps think their labour loſt; ſince I have taken care to leave even the former part as little diſfurniſhed with experiments and uſeful notions, as, the argument conſidered, I conveniently could. And ſince alſo, for the paucity of ſuch things in the firſt part, I have endeavoured to make amends in the ſecond, which is almoſt wholly phyſiological; concerning which, nevertheleſs, I ſhall admoniſh the reader: and indeed the whole tenets, that make up the following book, are by no means to be looked upon as publiſhed for an accurate treatiſe of the uſefulneſs of true phyſiology, but as familiar writings, that want only the formality of *ſalve* and *vale* to paſs for phyſiological and medical epiſtles; conſiſting of ſuch looſe obſervations, as I thought might be this way preſerved, and did not ſo properly belong to my other writings, as they ſeemed fitted for the uſe, and whereto I have applied them; namely, that being drawn up together into one treatiſe, their union might enable them to make the greater impreſſion, and might (ſomewhat at leaſt) recommend that ſort of learning to a beginner. And one thing, that muſt be eſpecially comprehended in this admonition, is, that the particulars I have mentioned, to ſhew of what uſe chymical experiments may be to a phyſician, are not, poſſibly, the chiefeſt, that even I could ſet down, if I were not reſtrained by ſome juſtifiable conſiderations; eſpecially till I ſee what entertainment the things I now adventure abroad, will meet with there: ſome of thoſe, I reſerve, appearing ſuch to me, that I confeſs, I do not ſlight them enough to be fond of obtruding them upon the publick, if I thought they would not be welcome to it. And I do ſo little deſire to have, what I have written, looked upon as the moſt that can be ſaid, to ſhew the uſefulneſs of experimental philoſophy, that I ſcruple not to acknowledge, there are things, which incline me to ſuſpect, that ſome in the world, though not particularly known to me, may have arcana, to which moſt of the proceſſes I reſerve, as well as all, that is commonly known in chymiſtry, may prove little more than trifles.

OF THE

USEFULNESS OF NATURAL PHILOSOPHY.

PART I.

Of its Uſefulneſs in reference to the Mind of Man.

ESSAY I.

Of the Uſefulneſs of EXPERIMENTAL PHILOSOPHY, principally as it relates to the Mind of Man.

The reaſon why the author endeavours to poſſeſs Pyrophilus *with the true value of experimental philoſophy.*

THE natural philoſophy, wont to be taught in ſchools, being little other then a ſyſtem of the opinions of *Ariſtotle*, and ſome few other writers, is not, I confeſs, *Pyrophilus*, very difficult to be learned; as being attainable by the peruſal of a few of the more current authors. But, *Pyrophilus*, that experimental philoſophy, which you will find treated of in the following Eſſays, is a ſtudy, if duly proſecuted, ſo difficult, ſo chargeable, and ſo toilſome, that I think it requiſite, before I propoſe any particular ſubjects to your inquiries, to poſſeſs you with a juſt value of true and ſolid phyſiology; and to convince you, that by endeavouring to addict you to it, I invite you not to miſpend your time or trouble on a ſcience unable to merit and requite it. In order, *Pyrophilus*, to the giving you this ſatisfaction, give me leave to mind you, that it was a ſaying of *Pythagoras*, worthy ſo celebrated a philoſopher, that there are two things, which moſt ennoble man, and make him reſemble the gods; *to know the truth*, and *to do good*. For, *Pyrophilus*, that diviner part of man, the ſoul, which alone is capable of wearing the glorious image of its author, being endowed with two chief faculties, the underſtanding and the will; the former is bleſt and perfectionated by knowledge, and the latter's lovelieſt and moſt improving property is goodneſs. A due reflection upon this excellent ſentence of him, to whom philoſophers owe that modeſt name, ſhould, methinks, *Pyrophilus*, very much endear to us the ſtudy of natural philoſophy. For there is no human ſcience, that does more gratify and enrich the underſtanding with variety of choice and acceptable truths; nor ſcarce any, that does more enable a willing mind to exerciſe a goodneſs beneficial to others.

That experimental philoſophy is conducive to the improving of man's underſtanding and to the increaſing man's power.

To manifeſt theſe truths more diſtinctly, *Pyrophilus*, and yet without exceeding that brevity, my avocations and the bounds of an Eſſay exact of me, I ſhall, among the numerous advantages accruing to men from the ſtudy of the book of nature, content my ſelf to inſtance only in a couple, that relate more properly to the *improving of men's underſtandings*, and to mention a few of thoſe many, by which it *encreaſes their power*.

THE two chief advantages, which a real acquaintance with nature brings to our minds, are, firſt, by inſtructing our underſtandings, and gratifying our curioſities; and next, by exciting and cheriſhing our devotion.

Arguments to prove, that man's curioſity for knowledge is much thereby gratified.

AND for the firſt of theſe: Since, as *Ariſtotle* teacheth, and was taught himſelf by common experience, *all men are naturally deſirous to know*; that propenſity cannot but be powerfully engaged to the works of nature, which being inceſſantly preſent to our ſenſes, do continually ſollicit our curioſities: of whoſe potent inclining us to the contemplation of nature's wonders, it is not, perhaps, the inconſiderableſt inſtance, that, though the natural philoſophy hitherto taught in moſt ſchools hath been ſo litigious in its theory, and ſo barren as to its productions; yet it hath found numbers of zealous and learned cultivators, whom ſure nothing but men's in-bred fondneſs for the object it converſes with, and the end it pretends to, could ſo paſſionately devote to it.

AND ſince that (as the ſame *Ariſtotle*, taught by his maſter *Plato*, well obſerves) admiration is the parent of philoſophy, by engaging us to enquire into the cauſes of the things at which we marvel; we cannot but be powerfully invited to the contemplation of nature, by living and converſing among wonders, ſome of which are obvious and conſpicuous enough to amaze even ordinary beholders; and others admirable and abſtruſe enough to aſtoniſh the moſt inquiſitive ſpectators.

THE bare proſpect of this magnificent fabrick of the univerſe, furniſhed and adorned with ſuch ſtrange variety of curious and uſeful creatures,

creatures, would ſuffice to tranſport us both with wonder and joy, if their commonneſs did not hinder their operations. Of which truth Mr. *Stepkins*, the famous oculiſt, did not long ſince ſupply us with a memorable inſtance: For (as both himſelf and an illuſtrious perſon that was preſent at the cure, informed me) a maid of about eighteen years of age, having by a couple of cataracts, that ſhe brought with her into the world, lived abſolutely blind from the moment of her birth; being brought to the free uſe of her eyes, was ſo raviſhed at the ſurprizing ſpectacle of ſo many and various objects, as preſented themſelves to her unacquainted ſight, that almoſt every thing ſhe ſaw, tranſported her with ſuch admiration and delight, that ſhe was in danger to loſe the eyes of her mind by thoſe of her body, and expound that myſtical Arabian proverb, which adviſes, *to ſhut the windows, that the houſe may be light.*

A relation of the tranſport and ſurprizal of a maid born blind, when being about 18 *years old, ſhe obtained the firſt ſight of the various objects of the world inſtantly preſented her with.*

BUT if the bare beholding of this admirable ſtructure, is capable of pleaſing men ſo highly; how much ſatisfaction, *Pyrophilus*, may it be ſuppoſed to afford to an intelligent ſpectator, who is able both to underſtand and to reliſh the admirable architecture and ſkilful contrivance of it: for the book of nature is to an ordinary gazer, and a naturaliſt, like a rare book of hieroglyphicks to a child, and a philoſopher; the one is ſufficiently with the oddneſs and variety of the curious pictures that adorn it; whereas the other, is not only delighted with thoſe outward objects, that gratify his ſenſe, but receives a much higher ſatisfaction, in admiring the knowledge of the author, and in finding out and inriching himſelf with thoſe abſtruſe and veiled truths dexterouſly hinted in them.

That the knowledge of the inward architecture, and contrivances of nature is more delightful than the ſight of the outward ſhapes.

YES, *Pyrophilus*, as the underſtanding is the higheſt faculty in man, ſo its pleaſures are the higheſt he can naturally receive. And therefore I cannot much wonder, that the famous *Archimedes* lighting in a bath upon an expedient to reſolve a perplexing difficulty in natural philoſophy, ſhould leap out of the bath, and run unclothed like a madman, crying nothing but Εὑρηκα, Εὑρηκα, *I have found it, I have found it.* Nor do I ſo much admire, as deplore the fatally venturous curioſity of the elder *Pliny*, who, as the younger relates, could not be deterred by the formidableneſs of deſtructive flames vomited by *Veſuvius*, from endeavouring by their light to read the nature of ſuch Vulcanian hills; but in ſpite of all the diſſuaſions of his friends, and the affrighting eruptions of that hideous place, he reſolved, that flaming wonder ſhould rather kill him, than eſcape him; and thereupon approached ſo near, that he loſt his life to ſatisfy his curioſity, and fell (if I may ſo ſpeak) a martyr to phyſiology. For we daily ſee alchymiſts hazard their lives on mineral experiments in furnaces, where, though the fires are not ſo vaſt and fierce, as thoſe that *Pliny* went to conſider, yet the (dangerous, when not pernicious) fumes, do ſometimes prove as fatal.

Examples and inſtances of the prevalence of the pleaſure, that ariſes from the attainment of knowledge

ONE would think, *Pyrophilus*, that the converſing with dead and ſtinking carcaſſes (that are not only hideous objects in themſelves, but made more ghaſtly by putting us in mind, that our ſelves muſt be ſuch) ſhould be not only a very melancholy, but a very hated employment. And yet, *Pyrophilus*, there are anatomiſts, who dote upon it; and I confeſs its inſtructiveneſs hath not only ſo reconciled me to it, but ſo enamoured me of it, that I have often ſpent hours much leſs delightfully, not only in courts, but even in libraries, than in tracing in thoſe forſaken manſions, the inimitable workmanſhip of the omniſcient Architect.

THE curious works of famous artificers are wont to invite the viſits, and excite the wonder of the generality of inquiſitive perſons. And I remember, that in my travels, I have often taken no ſmall pains to obtain the pleaſure of gazing upon ſome maſter-piece of art: but now, I confeſs, I could with more delight look upon a ſkilful diſſection, than the famous clock at *Straſburgh*. And, methinks, *Ariſtotle* diſcourſes very philoſophically in that place, where paſſing from the conſideration of the ſublimeſt productions of nature, to juſtify his diligence in recording the more homely circumſtances of the hiſtory of animals, he thus diſcourſes: *Reſtat* (ſaith he) *ut de animanti natura diſſeramus, nihil pro viribus omittentes vel vilius vel nobilius. Nam & in iis, quæ hoc in genere minùs grata noſtro occurrunt ſenſui, natura parens & autor omnium miras excitat voluptates hominibus, qui intelligunt cauſas & ingenuè philoſophantur. Abſurdum enim nulla ratione probandum eſt, ſi imagines quidem rerum naturalium non ſine delectatione propterea inſpectamus, quòd ingenium contemplamur, quod illas condiderit, id eſt, artem pingendi aut fingendi; rerum autem ipſarum naturæ ingenio miráque ſolertia conſtitutam contemplationem non magis proſequamur atque exoſculemur, modo cauſas perſpicere valeamus:* 'It remains (ſaith he) that we diſcourſe 'of the natures of animals, being circumſpect 'to omit none either of the nobler or inferiour 'ſort: for even from thoſe creatures, which leſs 'pleaſe our ſenſe, does the univerſal parent, 'nature, afford incredible contentments to ſuch 'perſons, as underſtand their cauſes, and philoſophize ingenuouſly. Since it were abſurd 'and inconſiſtent to reaſon, if we ſhould behold the portraitures of natural things with 'delectation, becauſe we obſerve the accurateneſs, wherewith they are deſigned, namely, the 'ſkill of painture or ſculpture; and not much 'more affect and purſue the contemplation of 'things themſelves, contrived by the exquiſite 'artifice and ſagacity of nature, provided we 'be able to underſtand their cauſes.' And the better to make out to you, *Pyrophilus*, the delightfulneſs of the ſtudy of natural philoſophy, let me obſerve to you, that thoſe pleaſing truths it teacheth us, do highly gratify our intellectual faculties, without diſpleaſing any of them: for they are none of thoſe criminal pleaſures, which injured and incenſed conſcience does very much allay, even in the fruition, and turns into torments after it. Nor are the enquiries I am recommending of that trifling and

That the knowledge of the moſt curious artificial works is not more delightful than the knowledge of natural.

Ariſt. de Part. Anim. lib. 1. c. 5.

That the delight herein is altogether inoffenſive.

and unſerviceable ſort of imployments, which though conſcience condemns not as unlawful for a Chriſtian, reaſon diſapproves as not worthy of a philoſopher; and wherewith to be much delighted, argues a weakneſs; as to be pleaſed with babes and whiſtles ſuppoſes unripe and weak intellectuals: but the contemplation of nature is an imployment, which both the poſſeſſors of the ſublimeſt reaſon, and thoſe of the ſevereſt virtue, have not only allowed, but cultivated. The learned author of the book *De Mundo*, aſcribed to *Ariſtotle*, begins it with this elogium of natural philoſophy: *Mihi quidem ſæpe* (ſays he) *divina quædam res, Alexander, admirationeque digna viſa eſt philoſophia; præcipuè verò in ea parte, in qua ſola ipſa ſublimè ſeſe tollens, ad contemplandas rerum naturas magno illic ſtudio contendit exiſtentem in eis veritatem pernoſcere.* 'Philoſophy (ſays he) 'O *Alexander*, hath oftentimes ſeemed to me 'a divine and admirable thing; but chiefly, 'that part of it, which aſpires to contemplate 'the natures of things, imploying its utmoſt 'power in ſearching out the truth contained 'in them.' The reaſonableneſs of which commendation he handſomely enough proſecutes in the ſubſequent diſcourſe; to which I ſhall refer you, that I may proceed to mind you, that *Pythagoras*, *Democritus*, *Plato*, and divers others of thoſe, whoſe wiſdom made after-ages reverence antiquity, did not only eſteem the truths of nature worth ſtudying for, but thought them too worth travelling for as far as thoſe eaſtern regions, whoſe wiſe-men were then cried up for the beſt expoſitors of the obſcure book of nature. And that ſevere teacher, and perſuaſive recommender of the ſtricteſt virtue, *Seneca*, (whoſe eminent wiſdom made him invited to govern him, that was to govern the world, and who ſo often and ſo excellently preſſes the huſbanding of our time) does not only in ſeveral paſſages of his writings praiſe a contemplation of nature, but writes himſelf ſeven books of natural queſtions, and addreſſes them to that very *Lucilius*, whom in his epiſtle he takes ſuch pains to make compleatly virtuous; and in his preface, after he had ſaid according to his manner, loftily, *Equidem tunc naturæ rerum gratias ago, cum illam non ab hac parte video, quæ publica eſt, ſed cum ſecretiora ejus intravi, cum diſco, quæ univerſi materia ſit, quis author, aut cuſtos, &c.* 'Then do I pay 'my acknowledgments to nature, when I be-'hold her not on the outſide, which is obvi-'ous to publick view, but am entered into her 'more ſecret receſſes; when I underſtand what 'the matter of the univerſe is, who its author, 'and preſerver, &c.' He concludes in the ſame ſtrain, *Niſi ad hæc admitterer, non fuerat operæ pretium naſci:* 'Had I been debarred 'from theſe things, it would not have been 'worth coming into the world.' And to add what he excellently ſays in another treatiſe, *Ad hæc quærenda natus* (ſays he, having ſpoken of enquiries concerning the univerſe) *æſtima quàm non multùm acceperit temporis, etiamſi illud totum ſibi vindicet, cui licet nihil facilitate eripi, nihil negligentia patiatur excidere; licet horas ſuas avariſſimè ſervet, & uſque in ultimæ ætatis humanæ terminos procedat; nec quicquid illi, ex eo quod natura conſtituit, fortuna concutiat; tamen homo ad immortalium cognitionem nimis mortalis eſt. Ergo ſecundum naturam vivo, ſi totum me illi dedi, ſi illius admirator cultorque ſum. Natura autem utrumque facere me voluit & agere, & contemplationi vocare:* 'Being 'born deſignedly for ſearching out theſe things, 'conſider, that the portion of time allotted to 'man is not great, if this ſtudy ſhould in-'groſs it all; ſince though he ſhould preſerve 'his hours with the greateſt frugality all his 'life-time, not ſuffering any to be ſtolen from 'him, or ſlide away negligently, and never be 'diſturbed by accidents of fortune in the im-'ployment nature has appointed him, yet is 'he too moral to attain the knowledge of im-'mortal things. Wherefore, I live agreeable 'to nature, when I give up my ſelf wholly to 'her, and am her admirer and adorer: more-'over, nature hath deſigned me to act, and 'imploy my ſelf in contemplation.' How far religion is from diſ-approving the ſtudy of phyſiology, I ſhall have occaſion to manifeſt ere long, when we ſhall come to ſhew, that it is an act of piety to offer up for the creatures the ſacrifice of praiſe to the creator; for, as anciently among the Jews, by virtue of an Aaronical extraction, men were born with a right to prieſthood; ſo reaſon is a natural dignity, and knowledge a prerogative, that can confer a prieſthood without unction or impoſition of hands. And as for reaſon, that is ſo far from making us judge that imployment unworthy of rational creatures, that thoſe philoſophers (as *Ariſtotle*, *Epicurus*, *Democritus*, *&c.*) that have improved reaſon to the greateſt height, have the moſt ſeriouſly and induſtriouſly imployed it to inveſtigate the truths, and promote the ſtudy of natural philoſophy.

Inſtances of the eſteem divers antient philoſophers had for it.

Seneca in Præf. lib. 1. Nat. Quæſt.

Sen. de Otio Sap. c. 32.

How this ſtudy conſpires with religion.

AND indeed, that noble faculty called reaſon, being conſcious of the great progreſs it may enable us to make in the knowledge of nature's myſteries, if it were induſtriouſly imployed in the ſtudy of them, cannot, but like a great commander, think it ſelf diſobliged by not being conſiderably employed. And certainly we are wanting to our ſelves, and are guilty of little leſs than our own degradation, that being by God's peculiar vouchſafement endowed with thoſe noble faculties of underſtanding, and diſcourſing, and placed amidſt a numberleſs variety of objects, that inceſſantly invite our contemplations, can content our ſelves to behold ſo many inſtructive creatures, which make up this vaſt univerſe, whoſe nobleſt part we are deſigned to be, with no more, or but little more diſcerning eyes than thoſe leſs favoured animals, to whom nature hath denied the prerogative of reaſon, as we deny our ſelves the uſe of it. *Ariſtotle* well obſerves, that among animals, man alone is of an erected ſtature; and adds, That it is becauſe his nature hath ſomething in it of divine: *Officium autem divini* (infers he) *eſt intelligere atque ſapere:* 'The qualifications of a divine being, are under-'ſtanding and wiſdom.' And it cannot but miſbecome the dignity of ſuch a creature to live ignorant or unſtudious of the laws and conſti-

The abſurdity of not imploying humane faculties on the contemplation of thoſe objects, to which they are fitted.

De part. Anim. lib. 4. c. 10.

tutions of that great commonwealth (as divers of the antients have not improperly ſtyled the world) whereof he is the eminenteſt part. And were we not lulled aſleep by cuſtom or ſenſuality, it could not but trouble, as well as it injures a reaſonable ſoul, to ignore the ſtructure and contrivance of that admirably organized body, in which ſhe lives, and to whoſe intervention ſhe owes the knowledge ſhe hath of other creatures.

IT is true indeed, that even the generality of men, without making it their deſign, know ſomewhat more of the works of nature, than creatures deſtitute of reaſon, can, by the advantage of that ſuperiour faculty, which cannot but even unurged, and of its own accord make ſome, though but ſlight, reflections on the information of the ſenſes: but if thoſe impreſſions be only received and not improved, but rather neglected; and if we (contenting our ſelves with the ſuperficial account given us of things by their obvious appearances and qualities) are beholden for that we know, to our nature, not our induſtry, we faultily loſe both one of the nobleſt imployments, and one of the higheſt ſatisfactions of our rational faculty. And he, that is this way wanting to himſelf, ſeems to live in this magnificent ſtructure, called the univerſe, not unlike a ſpider in a palace; who taking notice only of thoſe objects, that obtrude themſelves upon her ſenſes, lives ignorant of all the other rooms in the houſe, ſave that wherein ſhe lurks; and diſcerning nothing either of the architecture of the ſtately building, or of the proportion of the parts of it in relation to each other, and to the entire ſtructure, makes it her whole buſineſs, by intrapping of flies, to continue an uſeleſs life; or exerciſe herſelf to ſpin cobwebs, which, though conſiſting of very ſubtile threads, are unſerviceable for any other than her own trifling uſes. And that the contemplation of the world, eſpecially the higher region of it, was deſigned for man's imployment by nature's ſelf, even the heathen poet (perhaps inſtructed by *Ariſtotle*) could obſerve, who ſings,

Illuſtrated by the ſimilitude of a ſpider in a palace, taking notice of nothing beſide her own cobweb.

Pronaque cum ſpectent animalia cætera terram,
Os homini ſublime dedit, cœlumque tueri
Juſſit, & erectos ad ſidera tollere vultus.

'Wiſe nature, framing brutes with down-
'ward looks,
'Man with a lofty aſpect did endue,
'And bad him heaven with its bright glories
'view.

I might annex, *Pyrophilus*, the ſtory *Joſephus* tells us in the beginning of his *Jewiſh Antiquities*, that it was the holy *Seth* and his poſterity (who are in *Geneſis* ſtyled the ſons of God) that were the inventors of aſtronomy, whoſe more fundamental obſervations (to perpetuate them to mankind, and ſever them from the foretold deſtructions by fire and water) they engraved upon two pillars, the one of brick, the other of ſtone; the latter of which our hiſtorian reports to have been extant in *Syria* in his time. And it is an almoſt uncontrolled tradition, that the patriarch, whom God vouchſafes to ſtyle *his friend*, was the firſt teacher of aſtronomy and philoſophy to the Egyptians, from whom, long afterwards, the Grecians learned them. *Beroſus* himſelf records him to have been ſkilled in the ſcience of the ſtars, as he is cited by *Joſephus*, (*Ant.* lib. 1. c. 8.) who a little after ſpeaking of *Abraham* and the Egyptians, expreſly affirms, that *Numerorum ſcientiam & ſiderum benignè illis communicavit: nam ante Abrahami ad ſe adventum, Ægyptii rudes erant hujuſmodi diſciplinarum; quæ à Chaldæis ad Ægyptios profectæ, hinc ad Græcos tandem pervenerunt.*

The opinion that Ovid, Seth, Abraham, *and* Solomon *had of man's fitneſs for the ſtudy of aſtronomy and other phyſiology.*

Iſaiah xli. 8. James xi. 23.

BUT, *Pyrophilus*, to put it out of queſtion, that the ſublimeſt reaſon needs not make the poſſeſſor of it think the ſtudy of phyſiology an employment below him, that unequalled *Solomon*, who was pronounced the wiſeſt of men by their omniſcient Author, did not only juſtify the ſtudy of natural philoſophy, by addicting himſelf to it, but ennobled it by teaching it, and purpoſely compoſing of it, thoſe matchleſs records of nature, from which I remember ſome Jewiſh authors relate *Ariſtotle* to have borrowed divers; which (if it be true) may well be ſuppoſed to be the choiceſt pieces, that adorned his philoſophy, and which Providence perhaps deprived the world of, upon ſuch a ſcore, as it did the Jews of the body of *Moſes*, leſt men ſhould idolize it, or, as ſome Rabbies are pleaſed to inform us, leſt vicious men ſhould venture upon all kinds of intemperance, out of confidence of finding out by the help of thoſe excellent writings the cure of all the diſtempers their diſſoluteneſs ſhould produce.

Why Providence might deprive us of Solomon's *phyſiology.*

AND, *Pyrophilus*, yet a little further to diſcover to you the delightfulneſs of the contemplations of nature's works, give me leave to mind you of their almoſt unimaginable variety, as of a property, that ſhould, methinks, not faintly recommend natural philoſophy to curious and active intellectuals.

FOR moſt other ſciences, at leaſt as they are wont to be taught, are ſo narrow and circumſcribed, that he, who has read one of the beſt and receneſt ſyſtems of them, ſhall find little in the other books publiſhed on thoſe ſubjects, but diſguiſed repetitions; and a diligent ſcholar may in no long time learn, as much as the profeſſors themſelves can teach him. But the objects of natural philoſophy being as many as the laws and works of nature, are ſo various and ſo numberleſs, that if a man had the age of *Methuſelah* to ſpend, he might ſooner want time than matter, for his contemplations: and ſo pregnant is each of that vaſt multitude of creatures, that make up the naturaliſt's theme, with uſeful matter to employ men's ſtudy, that I dare ſay, that the whole life of a philoſopher ſpent in that alone would be too ſhort to give a full and perfect account of the natural properties and uſes of any one of ſeveral minerals, plants, or animals, that I could name. It is an almoſt incredible variety of vegetables, that the teeming earth, impregnated by God's *producat terra*, does in ſeveral regions produce. Botaniſts have, a pretty while ſince, reckoned

Of the delight, that may ariſe from the variety of objects, which nature produces.

up

That there be above 6000 ſubjects of the vegetable kingdom.

up near 6000 ſubjects of the vegetable kingdom; ſince when, divers other not deſcribed plants have been obſerved by herbariſts, the chief of which will, I hope, be ſhortly communicated to the world, by that curious and diligent botaniſt, my induſtrious acquaintance, Dr. *How*, to whom I not long ſince preſented a peculiar and excellent kind of pepper, whoſe ſhell taſtes not unlike cinnamon, and ſmells ſo like cloves, that with the odour I have deceived many, which he confeſt to be new even to him; it having been lately gathered in *Jamaica* (where it abounds) and preſented me by the inquiſitive commander of the Engliſh forces there. And yet, *Pyrophilus*, this great variety of ſimples could not deter either ancient or modern inquirers from writing entire treatiſes of ſome particular ones. So *Pliny* tells us, [a] that *Themiſon* the phyſician publiſhed a volume (for ſo he called it) of that vulgar and deſpiſed herb called Plantain. So the ſame [b] author tells us, that *Amphilochus* writ a volume *De Medica Herba, & Cytiſa*; and king [c] *Juba* another, of a ſort of *Nymphæa* by him found on mount *Atlas*. And in our times, not to mention thoſe many books, that have been written by phyſicians, of the ſtructure of man's body, and *De Uſu partium*, *Carolus Roſenbergius* writ ſome years ſince an entire book *of Roſes*, which he calls his *Rhodologia*: *Martinus Blochwitius* ſince publiſhed another book *of Elder*, under the title of *Anatomia Sambuci*. Among the chymiſts, *Angelus Sala* publiſhed in diſtinct treatiſes, his *Vitriologia*, *Tartarologia*, *Saccharologia*. *Untzerus* alſo writ peculiar tracts *De Mercurio*, *De Sulphure*, *De Sale*. And *Paracelſus* himſelf vouchſafed diſtinct treatiſes to *Hypericon*, *Perſicaria*, *Helleborus*, and ſome other particular plants. *Baſilius Valentinus* (one of the moſt knowing and candid chymical writers) publiſhed long ſince an excellent treatiſe of *Antimony* inſcribed *Currus triumphalis Antimonii*; but though in his other, he hath alſo taught us divers other things concerning it, yet he left ſo much undiſcovered in antimony, that *Angelus Sala* was thereby emboldened to publiſh his *Anatomia Antimonii*. And *Hamerus Poppius*, (if that be his true name,) *Johannes Tholdius*, and the experienced *Alexander Van Suchten*, thought fit to write entire treatiſes of that ſame mineral, by which if they ſeem to eclipſe the diligence of *Baſilius*, at leaſt they bore witneſs to his judgment: for modeſtly inviting his readers to make further inquiries into the nature and preparations of that abſtruſe mineral, he gives this account of his leaving many things unmentioned, *That the ſhortneſs of life makes it impoſſible for one man throughly to learn antimony, in which every day ſomething of new is diſcovered.* And I remember, that having lately given a chymiſt, upon his requeſt, ſome directions for drawing, not an imaginary mercury of antimony, as thoſe, which are wont to be taught by chymiſts, but a real fluid quickſilver; he ſome days ſince brought me about an ounce of it (which you may command when you pleaſe) as the firſt fruits of directions, differing enough from thoſe, which I have hitherto met with in authors. A peculiar way likewiſe of ſeparating from antimony, not ſuch a ſubſtance as thoſe, which are as improperly as vulgarly called antimonial ſulphurs, but a really combuſtible body, which looks and burns ſo like common brimſtone, that it is not eaſily diſtinguiſhable from it, we ſhall elſewhere, God willing, *Pyrophilus*, teach you. And I remember, that whereas, according to the way mentioned by *Baſilius* in his *Currus triumphalis*, and both generally tranſcribed by authors, and formerly practiſed by our ſelves, the tincture of the glaſs of antimony is very tedious to make, being to be drawn with ſpirit of vinegar, I once made a menſtruum to draw it more expeditiouſly; which having not hitherto met with, in any of the authors I have read, I ſhall not conceal from you. Taking then an arbitrary quantity of the beſt French verdigreaſe, and diſtilling it orderly in a ſtrong naked fire, I found the extorted liquor to extract (even in an ordinary digeſting heat) from powdered antimonial glaſs, a blood-red tincture in three or four hours; and my curioſity leading me to abſtract the menſtruum from the tinging powder, and put it again upon pulverized glaſs, I found it again highly tinged in very few hours. And proſecuting the experiment, I found, that by drawing off the menſtruum, and digeſting ſpirit of wine upon the remaining calx, I could ſoon obtain a red tincture, or ſolution; from which ſome chymiſts, if I ſhould tell them, what I have now told you, would perhaps expect no ordinary medicine. But this, I ſuppoſe, you will think leſs ſtrange, than that with a liquor eaſily ſeparated, by a way which I may elſewhere teach you, from an obvious vegetable, of which you may ſafely eat a whole pound at a time, I have drawn a deep red tincture, even from crude antimony, and that in not many hours, and without heat.

Of an excellent Jamaica pepper newly brought over.

Of divers ſingle ſubjects that require large treatiſes to unfold them.

How many treatiſes are already made of antimony, which yet has not been perfectly diſcovered.

Of a real mercury of antimony.

And a real combuſtible ſulphur of antimony, that burns like ordinary brimſtone.

A new tincture of antimonial glaſs, with the intire proceſs to draw it.

AND to theſe experiments of antimony, I might (partly from the communication of my friends, and partly from ſome trials of my own) add divers other undivulged experiments relating to that mineral, if it were not now more ſeaſonable, reſerving them for other papers, to mind you, that the learned *Kircherus* hath enriched us with a great volume in folio, of light and ſhadows; and another in quarto, of the load-ſtone: and yet none of theſe have ſo exhauſted the ſubjects they have treated of, but that an after enquirer may be able to recruit their obſervations with many new ones, perhaps more numerous or more conſiderable than the former: as after our learned countryman *Gilbertus* had written a volume of the load-ſtone, the Jeſuit *Cabæus* was not by that deterred from writing another of the ſame ſubject: and though ſince *Cabæus* the ingenious *Kircherus* have ſo largely proſecuted it in his voluminous *Ars Magnetica*, yet he has not reaped his field ſo clean, but that a careful gleaner may ſtill find ears enough to make ſome ſheaves. And what I have lately tried or ſeen, makes me think it very poſſible to recruit thoſe many of *Kircherus*, with ſome further magnetical experiments unmentioned in his book. And I have, the very day I writ this, made in that admi-

Of Gilbertus, Cabæus, and Kircher, who ſucceſſively writ the experiments of the load-ſtone.

admirable ſtone a not inconſiderable experiment, not extant (that I remember) there: for taking an oblong load-ſtone, and heating it red-hot, I found the attractive faculty in not many minutes, either altogether aboliſhed, or at leaſt ſo impaired and weakened, that I was ſcarce, if at all able to diſcern it. But this hath been obſerved, though not ſo faithfully related, by more than one; wherefore I ſhall add, that by refrigerating this red-hot load-ſtone either north or ſouth, I found that I could give its extremes a polarity (if I may ſo ſpeak) which they would readily diſplay upon an excited needle freely placed in æquilibrium: and not only ſo, but I could by refrigerating the ſame end ſometime north, and ſometime ſouth, in a very ſhort time change the poles of the load-ſtone at pleaſure, making that which was a quarter of an hour before the north pole, become the ſouth; and on the contrary, the formerly ſouthern pole become the northern. And this change was wrought on the load-ſtone, not only by cooling it directly north and ſouth, but by cooling it perpendicularly; that end of it which was contiguous to the ground growing the northern pole, and ſo (according to the laws magnetical) drawing to it the ſouth end of the needle; and that which was remoteſt from it, the contrary one: as if indeed the terreſtrial globe were, as ſome magnetick philoſophers have ſuppoſed it, but a great *Magnes*, ſince its effluviums are able, in ſome caſes, to impart a magnetick faculty to the loadſtone it ſelf. Some other experiments of this nature, not extant in *Kircherus*, we may have elſewhere fit opportunity to mention. And indeed, that ænigmatical mineral (if I may ſo call it) the load-ſtone, is a ſubject ſo fertile in rarities, that, I hear, he himſelf is reprinting that accurate treatiſe, with new large additions.

Of ſome new experiments hitherto undiſcovered of that ſtone.

NOR are the ſmalleſt and moſt deſpicable productions of nature ſo barren, but that they are capable both to invite our ſpeculations, and to recompenſe them. *Pliny* in the eleventh book of his natural hiſtory, where he treats of inſects, is a little after the entrance tranſported with an unwonted admiration of the workmanſhip of nature in them: *Nuſquam alibi* (ſays he) *ſpectatiore naturæ rerum artificio:* 'In no-'thing elſewhere (ſaith he) is the workman-'ſhip of nature more remarkable than in the 'contexture of theſe little creatures.' And after a wonder, not unworthy a philoſopher, he concludes, *Rerum natura nuſquam magis quam in minimis tota eſt:* 'Nature in her whole pow-'er is never more wholly ſeen than in her 'ſmalleſt works.' To which *epiphonema* he adds this ſober and philoſophical admonition: *Quapropter, quæſo, ne hæc legentes, quoniam ex his ſpernunt multa, etiam relata faſtidio damnent, cum in contemplatione naturæ nihil poſſit videri ſupervacaneum:* 'Wherefore I would requeſt 'the peruſers of theſe diſcourſes, that although 'the ſubjects we treat of are contemptible in 'their eyes, they would not therefore diſdain 'the relations we ſhall make of them; ſince 'nothing ought to ſeem ſuperfluous in the 'contemplation of nature.' I remember, that it is from the conſideration of ſo deſpicable a part as the ſkin of the ſoal of the foot, that *Galen* takes occaſion to magnify the wiſdom of God in thoſe excellent terms, that we ſhall have occaſion to mention hereafter. And, as he ſays rarely well, though ſome creatures ſeem made of much coarſer ſtuff than others, yet even in the vileſt, the Maker's art ſhines through the deſpicableneſs of the matter. For idiots admire in things the beauty of their materials; but artiſts, that of the workmanſhip: to which, after a great deal of philoſophical diſcourſe, he adds, *Neque oculo nec cerebro deterius eſt pes conſtructus, ſi utraque pars ad actiones, cujus gratia fuit facta, ſe habeat optimè; neque cerebrum ſine pede ſe probe haberet, neque pes ſine cerebro: eget enim, opinor, illud vehiculo, hic autem ſenſu:* 'Nor is the 'foot worſe contrived than the brain or eye, 'provided each part be duly diſpoſed for the 'performance of the actions to which it was 'deſigned: ſince the brain could not conve-'niently want the foot, nor the foot the brain. 'For, I conceive, that one ſtands in need of 'a ſupport for local motion; and the other, 'of a ſource, from whence to derive the facul-'ties of feeling.' To which we may annex that judicious reaſoning of *Ariſtotle*, who, deſcending from the contemplation of the ſublimer works of nature, to treat of the parts of animals, thus endeavours to keep his readers from thinking, that the object of it muſt render that enquiry deſpicable: *Reſtat* (ſays he) *ut de animanti natura diſſeramus.* And having ſet down thoſe words, which you have not long ſince read, in connection to theſe, he thus proſecutes his diſcourſe: *Quamobrem, viliorum animalium diſputationem perpenſionemque faſtidio quodam puerili ſpreviſſe, moleſtéque tuliſſe dignum nequaquam eſt: cum nulla res ſit naturæ, in qua non mirandum aliquod habeatur. Et quod Heraclitum ferant dixiſſe ad eos, qui cum alloqui eum vellent, quòd fortè in caſa furnaria quadam caloris gratia ſedentem vidiſſent, accedere temperarunt, ingredi enim eos fidenter juſſit; quoniam, inquit, ne huic quidem loco dii deſunt immortales; hoc idem in indaganda quoque natura animantium faciendum eſt. Aggredi enim quæque ſine ullo pudore debemus; cum in omnibus naturæ numen, & honeſtum pulchrumque inſit ingenium:* 'Wherefore it is altogether 'unſeemly to reject with a kind of childiſh 'nicety, or be offended at the diſcourſe and 'ſpeculation of inferior animals; ſince there 'is nothing in all nature, but contains in it 'ſomewhat worthy of admiration. And as it 'is recorded of *Heraclitus*, that ſeeing ſome 'perſons deſirous to ſpeak with him, refuſed 'to approach towards him, becauſe they be-'held him warming himſelf in a miſerable cot-'tage, he bad them come in without ſcruple, 'ſince here alſo (ſaith he) are the immortal 'gods preſent: ſo in like manner ought we 'to be highly perſuaded of the dignity of ani-'mals, when we make enquiries into their 'natures. Which we ought in no wiſe to be 'aſhamed of; ſince the mighty power and 'laudable wiſdom of nature is conſpicuous in 'all things.' Nay, *Paracelſus* himſelf, as haughty as he was, was philoſopher enough not to diſdain

That admirable ſpeculations may ariſe from the moſt deſpicable productions of nature.

diſdain to write a book *De Myſteriis Vermium*; wherein, though, according to his manner, he hath ſet down many extravagances, he is more candid in the delivery of ſeveral remedies (which experience hath recently taught us to be more effectual than probable) than in moſt other of his writings. And in that treatiſe he juſtly reprehends the lazineſs and pride of thoſe phyſicians, who not only neglect and ſcorn enquiries of nature themſelves, but when the fruits of ſuch enquiries are preſented them by others, inſtead of a grateful acceptance, receive them with contempt and deriſion. To which, a while after, he adds, what is moſt true, 'That 'God hath created nothing ſo vile, deſpicable, 'abject, or filthy in the world, that may not 'make for the health and uſe of man.' And certainly whatever God himſelf has been pleaſed to think worthy his making, its fellow-creature man ſhould not think unworthy of his knowing. Nor is it a diſparagement to a human notion, to repreſent a creature, which has the honour to have been framed according to a divine idea; and therefore the wiſeſt of men, in his natural hiſtory, ſcruples not to write as well of abject reptiles, as of lions, eagles, elephants, and other noble animals; and did not only treat of the tall cedars of *Lebanon*, but that deſpicable plant (whatever it be that is deſigned by the Hebrew *ezob*) which grows out of the wall. For my part, if I durſt think my actions fit to be examples, I ſhould tell you, that I have been ſo far from that effeminate ſqueamiſhneſs, that one of the philoſophical treatiſes, for which I have been gathering experiments, is of the nature and uſe of dungs. And though my condition does (God be praiſed) enable me to make experiments by others hands; yet I have not been ſo nice, as to decline diſſecting dogs, wolves, fiſhes, and even rats and mice, with my own hands. Nor, when I am in my laboratory, do I ſcruple with them naked to handle lute and charcoal.

Whatever God has thought worthy of making, man ſhould think unworthy of knowing.

I SHOULD here, *Pyrophilus*, ceaſe to entertain you with diſcourſes of the pleaſantneſs of natural philoſophy, but that I remember I have not yet told you, that the ſtudy of phyſiology is not only delightful, as it teaches us to know nature, but alſo as it teaches us in many caſes to maſter and command her. For the true naturaliſt (as we ſhall ſee hereafter) does not only know many things, which other men ignore, but can perform many things, which other men cannot do; being enabled by his ſkill not barely to underſtand ſeveral wonders of nature, but alſo partly to imitate, and partly to multiply and improve them. And how naturally we affect the exerciſe of this power over the creatures, may appear in the delight children take to do many things (which we may have occaſion to mention elſewhere) that ſeem to proceed from an innate propenſity to pleaſe themſelves in imitating or changing the productions of nature.

AND ſure it is a great honour, that the indulgent Creator vouchſafes to naturaliſts, that though he gives them not the power to produce one atom of matter, yet he allows them the power to introduce ſo many forms (which philoſophers teach to be nobler than matter) and work ſuch changes among the creatures, that if *Adam* were now alive, and ſhould ſurvey that great variety of man's productions, that is to be found in the ſhops of artificers, the laboratories of chymiſts, and other well furniſhed magazines of art, he would admire to ſee what a new world, as it were, or ſet of things has been added to the primitive creatures by the induſtry of his poſterity.

Of the dominion and power that phyſiology gives the proſperous ſtudiers of it.

AND though it be very true, that man is but the miniſter of nature, and can but duly apply agents to patients, (the reſt of the work being done by the applied bodies themſelves;) yet by his ſkill in making thoſe applications, he is able to perform ſuch things, as do not only give him a power to maſter creatures otherwiſe much ſtronger than himſelf, but may enable one man to do ſuch wonders, as another man ſhall think he cannot ſufficiently admire. As the poor Indians looked upon the Spaniards as more than men, becauſe the knowledge they had of the properties of nitre, ſulphur and charcoal duly mixed, enabled them to thunder and lighten ſo fatally, when they pleaſed. And this empire of man, as a naturaliſt, over the creatures may perchance be to a philoſophical ſoul preſerved by reaſon untainted with vulgar opinions, of a much more ſatisfactory kind of power or ſovereignty than that, for which ambitious mortals are wont ſo bloodily to contend. For oftentimes this latter being commonly but the gift of nature, or preſent of fortune, and but too often the acquiſt of crimes, does no more argue any true worth or noble ſuperiority in the poſſeſſor of it, than it, argues one braſs counter to be of a better metal than its fellows, in that it is choſen out to ſtand in the account for many thouſands pounds more than any of them. Whereas the dominion, that phyſiology gives the proſperous ſtudier of it (beſides that it is wont to be innocently acquired, by being the effect of his knowledge) is a power, that becomes man as man. And to an ingenious ſpirit, the wonders he performs bring perchance a higher ſatisfaction, as they are proofs of his knowledge, than as they are productions of his power, or even bring acceſſions to his ſtore.

ESSAY II. *Of the ſame.*

That the knowledge of nature excites and cheriſhes devotion.

THE next advantage, *Pyrophilus*, that we mentioned the knowledge of nature to bring to minds of men, is, that therein it excites and cheriſhes devotion; which when I ſay, *Pyrophilus*, I forget not, that there are ſeveral divines (and ſome of them eminent ones)

that out of a holy jealousy (as they think) for religion, labour to deter men from addicting themselves to serious and thorough inquiries into nature, as from a study unsafe for a Christian, and likely to end in atheism, by making it possible for men (that I may propose to you their objection as much to its advantage as I can) to give themselves such an account of all the wonders of nature, by the single knowledge of second causes, as may bring them to disbelieve the necessity of a first. And certainly, *Pyrophilus*, if this apprehension were well grounded, I should think the threatened evil so considerable, that instead of inviting you to the study of natural philosophy, I should very earnestly labour to dissuade you from it. For I, that had much rather have men not philosophers than not Christians, should be better content to see you ignore the mysteries of nature than deny the author of it. But though the zeal of their intentions keep me from harbouring any unfavourable opinion of the persons of these men, yet the prejudice that might redound from their doctrine (if generally received) both to the glory of God from the creatures, and to the empire of man over them, forbids me to leave their opinion unanswered; though I am sorry, that the necessity of vindicating the study I recommend to you from so heinous a crime as they have accused it of, will compel me to theologize in a philosophical discourse: which that I may do, with as much brevity as the weight and exigency of my subject will permit, I shall content myself only in the explication of my own thoughts, to hint to you the grounds of answering what is alledged against them.

The end of God's creation: his own glory. Job viii. 9.

AND first, *Pyrophilus*, I must premise, that though it may be a presumption in man, (who to use a Scripture expression, *is but of yesterday, and knows nothing, because his days upon the earth are but as a shadow*) precisely and peremptorily to define all the ends and aims of the omniscient God in his great work of the creation; yet perhaps, it will be no great venture to suppose, that at least in the creating of the sublunary world, and the more conspicuous stars, two of God's principal ends were, the manifestation of his own glory, and the good of men. For the first of these; *The Lord hath made all things for himself*, says the preacher; *for of him, and through him, and to him, are all things*, says the apostle. And, *Thou hast created all things, and for thy pleasure they are and were created*, say the twenty-four prostrate elders (representatives, perhaps, of the whole church of both testaments, propagated by the twelve patriarchs, and the like number of apostles) to their Creator; which truth, were it requisite, might be further confirmed by several other texts, which, to decline needless prolixity, I here forbear to insist on. Consonantly to this, we hear the Psalmist proclaiming that *the heavens declare the glory of God, and the firmament sheweth his handy-works.* To which purpose we may also observe, that though man were not created, till the close of the sixth day (the resident's arrival being obligingly suspended till the palace was made ready to entertain him) yet, that none of God's works might want intelligent spectators and admirers, the angels were created the first day, as divines generally infer from the words of God in *Job*; *Where wast thou, when I laid the foundations of the earth?* and a little after; *when the morning stars sang together, and all the sons of God shouted for joy.* Where, by the *morning stars* and *sons of God*, are supposed to be meant the newly created angels; one of whose earliest exercises was, it seems, to applaud the creation, and take thence occasion to sing hymns to the almighty author of it. I should not, *Pyrophilus*, add any thing further on this subject, but that having since the writing of these thoughts, met with a discourse of *Seneca*'s, very consonant to some of them, I suppose it may tend to your delight as well as to their advantage, if I present you some of the truths you have seen in my coarser language, dress't up in his finer and happier expressions. *Curiosum nobis* (saith he) *natura ingenium dedit, & artis sibi pulchritudinisque conscia spectatores nos tantis rerum spectaculis genuit, perditura fructum sui, si tam magna, tam clara, tam subtiliter ducta, tam nitida, & non uno genere formosa solitudini ostenderet; ut scias illam spectari voluisse, non tantum aspici, vide quem locum nobis dedit; nec erexit tantummodo hominem, sed etiam ad contemplationem factum, ut ab ortu sidera in occasum labentia prosequi posset, & vultum suum circumferre cum toto, sublime illi fecit caput, & collo flexibili imposuit. Deinde sena per diem, sena per noctem signa produxit; nullam non partem sui explicuit, ut per hæc, quæ obtulerat ejus oculis, cupiditatem faceret etiam cæterorum: nec enim omnia nec tanta vidimus quanta sunt, sed acies nostra aperit sibi investigando viam, & fundamenta veri jacit, ut inquisitio transeat ex apertis in obscura, & aliquid ipso mundo inveniat antiquius:* 'Nature, 'conscious to her self of her own beauty and 'artifice, hath given us a curious searching 'wit, and to so excellent and great shews be-'gat us to be spectators; otherwise she would 'have lost the fruit of her self, if to a desart 'and solitude she should have set forth so 'magnificent, so famous, so finely drawn, so 'fair and many ways beautiful pieces. That 'you may know she would not only have 'them seen, but looked upon, take notice of the 'place she hath given us: for she hath not 'only made man of an upright stature, but 'being so made, for better contemplation, that 'he might follow with his eye the course of 'the stars, from the rising to the setting, and 'carry about his looks, together with his 'whole body, she hath both given him a tall 'head, and placed that upon a flexible neck; 'then she shews six constellations by day, and 'six by night. She hath laid open every part 'of her self, that by those things, which she 'hath offered to the eyes of man, she might 'breed a desire of knowing the rest. Yet 'neither do we see all her works, nor those 'that we see, do we see in those proportions 'which they truly have; but our sight, by 'searching, does open a way unto it self, and 'lay the grounds of truth, that so inquiry 'may pass from things that are plain, to things

Job xxxviii. 7.

Sen. de Oti. Sap. 32.

Prov. xvi. 4.

Rom. xi. 36.

Psal xix. 1.

'that are obſcure, and find ſomewhat more 'ancient, even than the world it ſelf.' See *Sen. De Vita Beata*, cap. xxxii. And leſt you might be offended at his mentioning of nature, and ſilence of God, give me leave to inform you, that about the cloſe of the chapter immediately preceding that, whence the paſſage you come from reading is tranſcribed, having ſpoken of the enquiries of philoſophers into the nature of the univerſe, he adds, *Hæc qui contemplatur, quid Deo præſtat? ne tanta ejus opera ſine teſte ſint*; 'What does he, that 'contemplates the nature of the univerſe, of 'honour unto God? this, that his great works 'are not without a witneſs.'

That man's good is a ſecond end, proved by ſcripture.

AND to proceed to that, which we have formerly aſſigned for the ſecond end of the creation; that much of this viſible world was made for the uſe of man, may appear, not only from the time of his creation (already taken notice of) and by the commiſſion given to the firſt progenitors of mankind, to *repleniſh the earth and ſubdue it, and to have dominion over the fiſh of the ſea, and over the fowls of the air, and over all the earth, and over every living thing that creepeth or moveth on the earth:* but alſo by God's making thoſe noble and vaſt luminaries, and other bodies, that adorned the ſky, to give light upon the earth, though inferiour to them in dimenſions, and *to divide between the day and between the night, and to be for ſigns, and for ſeaſons, and for days, and for years.* To this agrees that paſſage in the prophet, *Thus ſaith the Lord that created the heavens, God himſelf that formed the earth, and made it, He hath eſtabliſhed it, He created it not in vain, He formed it to be inhabited, &c.* And the inſpired poet ſpeaks of man's dignity in very comprehenſive terms, *For thou* (ſays he to his Maker) *haſt made him little lower than the angels, and haſt crowned him with glory and honour; Thou madeſt him to have dominion over the works of thy hands, thou haſt put all things under his feet.*

Gen. i. 28, 29.

Iſai. xlv. 18.

Pſal. v. 5, 6.

THE ſame truth may be confirmed by divers other texts, which it might here prove tedious to inſiſt on. And therefore I ſhall rather obſerve, that conſonantly thereunto, God was pleaſed to conſider man, ſo much more than the creatures made for him, that he made the ſun it ſelf at one time to ſtand ſtill, and at another time to go back, and divers times made the parts of the univerſe forget their nature, or act contrary to it; and has (in ſum) vouchſafed to alter by miracles the courſe of nature, for the inſtruction or relief of man (as when the fire ſuſpended its deſtructive operation, whilſt the three reſolute Jews, with their protector, walked unharmed in the midſt of thoſe flames that deſtroyed the kindlers; and as the heavy iron, emerged up to the ſwimming piece of wood, miraculouſly by *Eliſha* made magnetical.) And you may alſo, *Pyrophilus*, take notice, that when *Adam* had tranſgreſſed, immediately the ground was curſed for his ſake. And as it is not unuſual in human juſtice to raze the very houſes of regicides and reſembling traitors; ſo when the provocations of *Sodom* ſwelled high enough to reach heaven, God did not only deſtroy the inhabitants from the face of the earth, but for the inhabitants ſins deſtroyed the very face of the earth. So when in *Noah*'s time, a deluge of impiety called for a deluge of waters, God, looking upon the living creatures, as made for the uſe of man, ſtuck not to deſtroy them with him, and for him; but involved in his ruin all thoſe animals, that were not neceſſary to the perpetuation of the ſpecies, and the ſacrifice due for *Noah*'s preſervation. And ſo, when (in the laſt days) the earth ſhall be repleniſhed with thoſe ſcoffers mentioned by St. *Peter*, *who will walk after their own luſts*, and deride the expectation of God's foretold coming to judge and puniſh the ungodly, their impiety ſhall be as well puniſhed as ſilenced by the unexpected flames (perhaps haſtened by that very impiety) that ſhall either deſtroy or transfigure the world. For as by the law of *Moſes*, the leprous garment, which could not be recovered by being waſhed in water, was to be burned in the fire; ſo the world, which the deluge could not cleanſe, a general conflagration muſt deſtroy.

2 Pet. iii. 3, 5, 6, 7, 8, 10.

Lev. xiii. 54, 55.

The ſame proved by reaſon and authority, xxvi, xxvii, xxvii.

NOR is reaſon it ſelf backward to countenance what we teach. For it is no great preſumption to conceive, that the reſt of the creatures were made for man, ſince he alone of the viſible world is able to enjoy, uſe, and reliſh many of the other creatures, and to diſcern the omniſcience, almightineſs, and goodneſs of their author in them, and return him praiſes for them. It is not for themſelves, that the rubies flame, other jewels ſparkle, the bezoar-ſtone is antidotal; nor is it for their own advantage, that fruitful trees ſpend and exhauſt themſelves in annual profuſions. The light, which he diffuſes through the world, is uſeleſs to the ſun himſelf, whoſe inanimate being makes him incapable of delighting in his own ſplendor, which he receives but to convey it to the earth, and other by him illuminated globes: whence probably the Hebrews called him *Shemeſh*, which grammarians derive from the root *Shemaſh*, ſignifying, in the Chaldean tongue, *to ſerve*, or *miniſter to*; the ſun being the great miniſter of nature, and ſervant general of the univerſe. And as animals alone, among the creatures, ſeem to have a proper ſenſe of, and complacency in, their own being; ſo man alone among animals is endowed with reaſon, at leaſt ſuch a pitch of it, as by which he can diſcern God's creatures to be the gifts of God, and refer them to their Creator's glory. This truth I find not only embraced by Chriſtians, but aſſented to even by Jews and Heathens. Among the Jews, my learned acquaintance, *Manaſſeh Ben Iſrael*, profeſſedly labours to prove it by ſcripture and tradition, (though in ſome of his arguments, he might appear more a philoſopher, if he would have appeared leſs a Rabbi) and among other paſſages I remember he alledges that, wherein the wiſe man ſays (as our tranſlators engliſh it) *that the righteous is an everlaſting foundation*, which he renders, *juſtus eſt columna mundi, the juſt man is the pillar of the world.* And indeed, if the context did not ſomewhat diſfavour the interpretation, the

How the ſun (Sheneſh) *is the great miniſter of the univerſe.*

In Probl. de Creat.

Prov. x. 25. Gen. vi. 9.

Hebrew

Gen. ii. 26, 28, 29. Pſal. viii. 7. Heb. ii. 7. Job v. 3. Ho. ii. 28, 21, 22. Rom. viii. 28. 2 Cor. iii. 22. 2 Tim. iv. 3. 2 King vi. 5, 6.

Hebrew words [*tzadîk yesôd olám*] would well enough bear the ſenſe aſſigned them. Congruouſly whereunto, I remember, that when *Noah* (who is called in ſcripture a righteous
2 Pet. ii. 5. man, and κήρυξ δικαιοσύνης, a *herald*, or *proclaimer of righteouſneſs*) offered up that noble ſacrifice of all the ſorts of clean beaſts and fowls, as a thank-offering for the reprieve of the world, God is ſaid to have *ſmelled a ſavour of reſt*, and to have reſolved in his heart never to curſe the ground for man's ſake, but to
Gen. viii. 21, 22. continue the viciſſitudes of ſummer, and winter, day, and night, *&c.* as long as the earth ſhall remain. And among the philoſophers themſelves, the truth we are now manifeſting, has not been altogether ignored. For though *Seneca* ſomewhere, more wittily than truly,
Secundo *De Ira*, cap. 27. ſays, *Non cauſa mundo ſumus hyemem æſtatemque referendi; ſuas iſta leges habent, quibus divina exercentur. Nimis nos ſuſpicimus, ſi digni nobis videmur, propter quos tanta moveantur:* 'We 'are not the cauſe of the ſeaſons and returns 'of ſummer and winter to the world: theſe 'have their own laws, accommodated to the 'exerciſe of divine beings. We arrogate too 'much honour to our ſelves, if we eſteem our 'ſelves worthy, that ſuch vaſt bodies ſhould 'fulfil ſuch motions for our ſakes.' Yet *Lactantius* (not to mention other authors) tells us, that the *Stoicks generally believed the world to*
De Ira Dei, cap. 13. *have been made for man. Vera eſt* (ſays he) *ſententia Stoicorum, qui aiunt noſtra cauſa mundum fuiſſe conſtructum. Omnia enim, quibus conſtat, quæque generat ex ſe mundus, ad utilitatem hominis accommodata ſunt:* 'True is the opinion 'of the Stoicks, that ſay, how that for our 'ſakes the world was made; for all things, that 'are, and that the world doth by itſelf generate, 'are accommodated to the advantage of man.' And *Seneca* himſelf ſpeaks elſewhere almoſt as if he had read and believed the beginning of
De Benef. cap. 28. *Geneſis: Dii* (ſays he) *non per negligentiam nos genuere, quibus tam multa genuerant: cogitavit enim nos ante natura, quam fecit:* 'The gods 'were not careleſs or unconcerned in the mak-'ing of man, for whom they made ſo many 'other creatures: for nature deſigned us, and 'drew us out in idea, before ſhe made us.'

NOR were the Stoicks the only philoſophers, to whom the contemplation of the univerſe diſcovered this end of it. For to inſtance now in *Cicero* only; *Quorum igitur causâ*
Secundo *De Nat. Deor.* (ſays that great orator) *effectum eſſe mundum? Eorum ſcilicet animantium, quæ ratione utuntur: hi ſunt dii & homines, quibus profecto nihil eſt melius*; 'And for whoſe ſake then, was the 'world made? for thoſe beings, that have 'reaſon and intelligence, *viz.* gods and men, 'than whom, no being is more excellent.'

HAVING thus premiſed, *Pyrophilus*, that two of God's principal aims in the creation were the manifeſtation of his own glorious attributes, and the welfare of his nobleſt viſible creature, man; it will not be perhaps difficult for you to diſcern, that thoſe, who labour to deter men from ſedulous enquiries into nature, do (though, I grant, deſignleſly) take a courſe, which tends to defeat God of both thoſe mentioned ends.

That accommodation and delight, which the creatures might afford man, is much impaired by the want of natural philoſophy.

For to ſpeak, firſt, to the laſt of them, that man's external fruition of the creatures, and the delight and accommodation which they may afford him, muſt be highly prejudiced and impaired by his ignorance of that natural philoſophy, wherein his dominion over the creatures chiefly conſiſts, what we ſhall ſay hereafter concerning the uſefulneſs of the knowledge of nature to human life, will ſufficiently evince. But ſuch an animal fruition (if I may ſo call it) of the works of nature affords not man all the good, that God deſigned him in them. For religion being, not only the great duty of man, but the grand inſtrument of his future happineſs, which conſiſts in an union with, and fruition of God, during that endleſs term, that ſhall ſucceed the expiration of his tranſitory life on earth; whatever increaſes or cheriſhes his religion, deſerves to be looked on as a great contributer to his happineſs. And we may therefore venture to affirm, that the knowledge of the creatures does leſs advantage man, as it ennables him to maſter them, than as it aſſiſts him, by admiring and ſerving him, to become acceptable to their author. And whatever our diſtruſtful adverſaries are pleaſed to ſurmiſe to the contrary, certainly God intended, that his creatures ſhould afford not only neceſſaries and accommodations to our animal part, but inſtructions to our intellectual. The world is wont to be ſtyled not unfitly by divines, the Chriſtian's inn; but perchance it may be altogether as properly called his ſhip: for whereas both appellations ſuppoſe him a traveller, the inn, though it refreſh him in his journey, does not further him in it, but rather retard his progreſs, by detaining him in one place; whereas a ſhip, not only ſerves the paſſenger for an inn when he is weary, but helps to convey him towards his journey's end. And according to this notion, to ſuppoſe, that God hath placed in the world innumerable things to feed man, and delight him, and none to inſtruct him, were a conceit little leſs injurious to God, than it were to a wiſe merchant, that ſends perſons he loves to a far country, to think, that he would furniſh their cabinets with plenty of proviſions, ſoft beds, fine pictures, and all other accommodations for their voyage, but ſend them to ſea diſprovided of ſea-charts, and mariner's compaſſes, and other requiſite helps to ſteer their courſe by to the deſired harbour.

That the inſtructions to our intellectual part are more conſiderable than the accommodations we have from nature to our animal part.

Of the hints of natural philoſophy in the hiſtory of the creation, and other references to it in other places.

AND indeed ſo far is God from being unwilling, that we ſhould pry into his works, that by divers diſpenſations he impoſes on us, little leſs than a neceſſity of ſtudying them. For firſt he begins the book of ſcripture with the deſcription of the book of nature, of which he not only gives us a general account, to inform us, that he made the world (ſince for that end, the very firſt verſe in the bible might have ſufficed) but he vouchſafes us by retail the narrative of each day's proceedings; and in the two firſt chapters of *Geneſis*, is pleaſed to give nobler hints of natural philoſophy than men are yet perhaps aware of. Though, that in moſt other places of the ſcripture, where the works of nature are mentioned but incidently, or in order

ces. 30, 31.

to

to other purpoſes, they are ſpoken of rather in a popular than accurate manner, I dare not peremptorily deny, being unwilling to intereſt the reputation of Holy Writ (deſigned to teach us rather divinity than philoſophy) in the doubtful contentions of naturaliſts, about ſuch matters, as may (though the hiſtory of the creation cannot) be known by the meer light of natural reaſon. We may next obſerve, that God has made ſome knowledge of his created book, both conducive to the belief, and neceſſary to the underſtanding of his written one; our Saviour making it one cauſe of the Sadducees great error about the reſurrection, that they *knew not the power of God.* And the Scripture being ſo full of alluſions to, and compariſons borrowed from the properties of the creatures, that there are many texts not clearly intelligible without ſome knowledge of them; as may appear even by the firſt Goſpel (the promiſe *that the ſeed of the woman ſhould bruiſe the ſerpent's head, and have his heel bruiſed by that ſubtle creature*) preached to fallen man in *Paradiſe*, and by the repreſentation of the world's four great monarchies, and the genius of each of them under the notion of four beaſts, in *Daniel*'s prophetick viſion: and that often repeated precept of our great Maſter to his diſciples is couched in an expreſſion alluding to the properties of animals. For where he commands them to be wiſe as ſerpents, and harmleſs as doves, he does not only recommend to them a ſerpentine warineſs in declining dangers, but ſeems alſo to preſcribe not alone an inoffenſiveneſs towards others(the conſpicuouſneſs of which quality in pigeons hath made them, though erroneouſly, be ſuppoſed to have no gall,) but alſo as harmleſs a way of eſcaping the dangers they are actually ingaged in, as that of doves, who being purſued by birds of prey, endeavour to ſave themſelves not by fight, but only by flight.

AND indeed ſo many of the texts in Scripture are not to be competently illuſtrated, without ſome knowledge of the properties of the creatures related to in them, that I wonder not that *Levinus Lemnius*, *Frantzius*, *Ruæus*, and other learned men have thought it requiſite to publiſh entire treatiſes, ſome of the animals, others of the ſtones, and others of the works of nature mentioned in Scripture. Only I could wiſh, that they had been as wary in their writings as commendable for their intentions, and had not ſometimes admitted doubtful or fabulous accounts into comments upon that book, whoſe prerogative it is to teach nothing but truth.

NOR ought their labours to deter others from cultivating the ſame theme: for as (ſuch is God's condeſcenſion to human weakneſs) moſt of the texts, to whoſe expoſition phyſiology is neceſſary, may be explicated by the knowledge of the external, or at leaſt more eaſily obſerved qualities of the creatures; ſo, that there are divers not to be fully underſtood without the aſſiſtance of more penetrating indagations of the abſtruſities of nature, and the more unobvious properties of things, an intelligent and philoſophical peruſer will readily diſcern.

Now if you ſhould put me upon telling you, *Pyrophilus*, what thoſe attributes of God are, which I ſo often mention to be viſibly diſplayed in the fabrick of the world, I can readily anſwer you, that though many of God's attributes are legible in his creatures, yet thoſe, that are moſt conſpicuous there, are his power, his wiſdom, and his goodneſs, in which the world, as well as the bible, though in a differing, and in ſome points a darker way, is deſigned to inſtruct us; which, that you may not think to be affirmed gratis, we muſt inſiſt a while on each of the three.

How God's power is conſpicuous in the creatures. 32, 33, 34.

AND firſt, how boundleſs a power, or rather what an almightineſs is eminently diſplayed in God's making out of nothing all things, and without materials or inſtruments conſtructing this immenſe fabrick of the world, whoſe vaſtneſs is ſuch, that even what may be proved of it, can ſcarcely be conceived, and after a mathematical demonſtration its greatneſs is diſtruſted! which yet is, I confeſs, a wonder leſs to be admired, than the power expreſſed by God in ſo immenſe a work, which nevertheleſs ſome modern philoſophers (whoſe opinions I find ſome cabaliſts to countenance) ſuppoſe to be not the only production of God's omnipotence. Not to mention elephants, or whales, ſome of which an hyperboliſt would not ſcruple to call moving mountains, and floating iſlands; and to paſs by thoſe ſtupendous hills, and thoſe ſeas, where the light loſes it ſelf, as objects, which their nearneſs only repreſents ſo bulky; let us haſten to conſider, that whereas the terreſtrial globe we men inhabit, contains, beſides all thoſe vaſt kingdoms, the union of ſome of which conſtituted the world's four celebrated monarchies, thoſe ſpacious (ſince detected) American regions, that have been deſervedly ſtyled the new world; and that whereas the common account makes the circuit of this terreſtrial globe to be no leſs than 22600 *Italian* miles, conſiſting each of 1000 geometrical paces, (which number the more recent account of the accurate *Gaſſendus* makes amount to 26255 miles of the ſame meaſure;) whereas, I ſay, this globe of earth and water ſeems to us ſo vaſt, aſtronomers teach us, that it is but a point in compariſon of the immenſity of heaven; which they not irrationally prove by the parallaxis (or circular difference betwixt the place of a ſtar, ſuppoſed to be taken by two obſervations, the one made at the centre, and the other on the ſurface of the earth) which *Gaſſendus* confeſſeth to be undiſcernible in the fixt ſtars; as if the terreſtrial globe were ſo mere a point, that it were not material, whether a fixt ſtar be looked upon from the centre, or from the ſurface of the earth. This may leſſen our wonder at the Ptolemæans making the ſun (which ſeems not half a foot over) to be above a hundred ſixty and ſix times bigger than the earth, and diſtant from it one thouſand one hundred ſixty and five ſemi-diameters of the earth, each of which contains, according to the aforementioned computation of *Gaſſendus*, 4177 miles; and at their ſuppoſing the fixt ſtars (whoſe diſtance the ſame author, as a Ptolemæan, ſupputes to be 19000 ſemi-diame-

Gaſſend. Inſt. Aſtr. l. 2. c. 13

ters of earth) ſo great, that they conclude each of the fixed or ſmalleſt magnitude to be no leſs than 18 times greater than the whole earth, and each ſtar of the firſt or chief magnitude to exceed the terreſtrial globe 108 times. And as for the Copernicans (that growing ſect of aſtronomers) they, as their hypotheſis requires, ſuppoſe the vaſtneſs of the firmament to be exceedingly greater, than the ancients believed it. For *Philippus Lansbergius*, who ventured to aſſign diſtances and dimenſions to the planets and fixed ſtars (which *Copernicus* forbore to do) ſuppoſes as well as his maſter, that the great orb it ſelf (as the Copernicans call that, in which they eſteem the earth to move about the ſun) though its ſemi-diameter be ſuppoſed to be 1500 times as great as that of the earth, is but as a point in compariſon of the firmament or ſphere of the fixed ſtars; which he ſuppoſes to be diſtant from the earth, no leſs than 28,000 ſemi-diameters of the great orb, that is, 42,000,000, of ſemi-diameters of the earth; or, according to the former computation of common miles, 175,434,000,000, which is a diſtance vaſtly exceeding that, which the Ptolemæans ventured to aſſign, and ſuch as even imagination it ſelf can hardly reach to. I confeſs indeed, that I am not ſo well ſatisfied with the exactneſs (nor perhaps with the grounds) of theſe kinds of computations, by reaſon of the difficulty I have met with in making exact celeſtial obſervations with either teleſcopes, or other inſtruments, ſufficiently witneſſed, by the great diſparity remarkable betwixt the computations of the beſt artiſts themſelves. But on the other ſide I am not ſure, but that even the Copernicans aſcribe not too great a diſtance to ſome of the fixed ſtars; ſince (for aught we yet know) thoſe of the ſixth magnitude, and thoſe, which our teleſcopes diſcover (though our bare eyes cannot) are not really leſs than thoſe of the firſt magnitude, but only appear ſo by reaſon of their greater diſtance from our eyes: as ſome fixed ſtars ſeem no bigger than *Venus* and *Mercury*, which are much leſſer than the earth. And therefore upon ſuch conſiderations, and becauſe the modeſteſt computation allows the firmament to be great enough to make the earth but a point in compariſon of it; it will be ſafe enough, as well as juſt, to conclude with the Pſalmiſt, *Great is the Lord, and greatly to be praiſed; and his greatneſs is unſearchable.*

Gaſſend. lib. 3. cap. 11.

How God's wiſdom is conſpicuous in them.

THE next attribute of God, that ſhines forth in his creatures, is his wiſdom; which to an intelligent conſiderer appears very manifeſtly expreſſed in the world, whether you contemplate it as an aggregate or ſyſtem of all natural bodies, or conſider the creatures it is made up of, both in their particular and diſtinct natures, and in relation to each other, and the univerſe, which they conſtitute. In ſome of theſe the wiſdom of God is ſo conſpicuous, and written in ſuch large characters, that it is legible even to a vulgar reader: but in many others the lineaments and traces of it are ſo delicate and ſlender, or ſo wrapt up and covered with corporeity, that it requires an attentive and intelligent peruſer. So numberleſs a multitude, and ſo great a variety of birds, beaſts, fiſhes, reptiles, herbs, ſhrubs, trees, ſtones, metals, minerals, ſtars, *&c.* and every one of them plentifully furniſhed and endowed with all the qualifications requiſite to the attainment of the reſpective ends of its creation, are productions of a wiſdom too limitleſs not to be peculiar to God: to inſiſt on any one of them in particular (beſides that it would too much ſwell this diſcourſe) might appear injurious to the reſt; which do all of them deſerve that extenſive exclamation of the Pſalmiſt, *How manifold are thy works, O Lord; in wiſdom haſt thou made them all.* Pſal. civ. 24. And therefore I ſhall content my ſelf to obſerve in general, that, as highly as ſome naturaliſts are pleaſed to value their own knowledge, it can at beſt attain but to underſtand and applaud, not emulate the productions of God. For as a novice, when the curiouſeſt watch the rareſt artiſt can make, is taken in pieces and ſet before him, may eaſily enough diſcern the workmanſhip and contrivance of it to be excellent; but had he not been ſhewn it, could never have of himſelf deviſed ſo ſkilful and rare a piece of work; ſo, for inſtance, an anatomiſt, though when by many and dextrous diſſections of human bodies, and by the help of mechanical principles and rules (without a competent ſkill wherein, a man can ſcarce be an accompliſhed and philoſophical anatomiſt) he has learned the ſtructure, uſe, and harmony of the parts of the body, he is able to diſcern that matchleſs engine to be admirably contrived, in order to the exerciſe of all the motions and functions, whereto it was deſigned: and yet this artiſt, had he never contemplated a humane body, could never have imagined or deviſed an engine of no greater bulk, any thing near ſo fitted to perform all that variety of actions we daily ſee performed either in or by a human body. Thus the circular motion of the blood, and ſtructure of the valves of the heart and veins (the conſideration whereof, as himſelf told me, firſt hinted the circulation to our famous *Harvey*) though now modern experiments have for the main (the modus ſeeming not yet ſo fully explicated) convinced us of them, we acknowledge them to be very expedient, and can admire God's wiſdom in contriving them: yet thoſe many learned anatomiſts, that have for many ſucceeding ages preceded both Dr. *Harvey* and *Columbus*, *Ceſalpinus*, *Padre Paulo*, and Mr. *Warner* (for each of theſe four laſt are ſuppoſed by ſome to have had ſome notion of the circulation) by all their diligent contemplation of human bodies, never dreamed (for aught appears) of ſo advantageous an uſe of the valves of the heart, nor that nimble circular motion of the blood, of which our modern circulators think they diſcern ſuch excellent uſe, not to ſay, neceſſity.

Particular obſervations of the ſtructure of human bodies.

AND though it be true, that the greater works of God do as well declare his great wiſdom as his power, according to that of the inſpired philoſopher; *The Lord by wiſdom hath founded the earth, by underſtanding hath he eſtabliſhed the heavens. By his knowledge the depths are broken up, and the clouds drop down* Prov. viii. 19, 20.

the

the dew; yet does not his wiſdom appear leſs in leſſer creatures; for there is none of them ſo little, but it would deſerve a great deal of our wonder, did we attentively enough conſider it. And as *Apelles* (in the ſtory) was diſcovered by the ſkilful *Protagoras*, by ſo neat and ſlender a line, that *Protagoras*, by being ſcarce able to diſcern it, diſcerned it to have been drawn by *Apelles:* ſo God, in theſe little creatures, oftentimes draws traces of omniſcience, too delicate to be liable to be aſcribed to any other cauſe. I have ſeen elephants, and admired them leſs than the ſtructure of a diſſected mole, which hath better eyes than thoſe, that will not ſee a deſignation in the dimneſs of its eyes (made only to ſee the light, not other objects by the help of it) and the unwonted poſture of its feet, given it not to run on the ground, but to dig it ſelf a way under ground. And, as deſpicable as their littleneſs makes the vulgar apt to think ſome creatures, I muſt confeſs my wonder dwells not ſo much on nature's clocks (if I may ſo ſpeak) as on her watches, and is more exerciſed in the coyneſs of the ſenſitive plant, and the magnetical properties of a ſmall and abject loadſtone, than the bulk of the talleſt oaks, or thoſe vaſt rocks, made famous by ſhipwrecks. I have paſſed the *Alps*, and have ſeen as much to admire at in an ant-hill; and have ſo much wondered at the induſtry of thoſe little creatures themſelves, that inhabited it, that I have ceaſed to wonder at their having given a theme to *Solomon*'s contemplation. Thoſe vaſt exotick animals, which the multitude flocks to ſee, and which men give money to be allowed to gaze on, have had many of them leſs of my admiration than the little caterpillar, (as learned naturaliſts eſteem it) to which we are beholden for ſilk. For (not to mention all the obſervables crouded by nature in that little worm) I thought it very well deſerved my wonder (when not long ſince I kept ſome of them purpoſely to try experiments) how this curious ſpinſter, after he had buried himſelf alive in the precious tomb he had wrought for himſelf out of his own bowels, did caſt off his former ſkin and legs, and, in ſhew, his former nature, appearing for divers days but an almoſt moveleſs maggot; till at length, diveſting this ſecond tegument alſo (in which neſt, phœnix-like, he had been regenerated out of his own remains) he came forth (if I may ſo ſpeak) out of his attiring room under another form, with wings, eyes, and legs, *&c.* to act a new part upon the ſtage of the world; which having ſpent ſome days, without feeding (that I could obſerve) in providing for the propagation of his ſpecies, he forſakes and dies. And I the rather mention the ſilk-worm, becauſe that there have been of late divers ſubtle ſpeculators, who would fain perſuade us, that animals do nothing out of inſtinct, or, if you pleaſe, innate or ſeminal impreſſions; but ſpin, build neſts, and perform all the other actions, for which they are admired, barely by imitation of what they have ſeen done by others of the ſame kind. But in the ſilk-worm (at leaſt here in *England*) this plauſible opinion will not hold: for the ſilk-worms I kept, were not hatched but in the ſpring, out of eggs laid ſome days in the ſun; and the worms, that laid thoſe eggs, being every one of them dead the winter before, it was impoſſible theſe new ſilk-worms, when they firſt began to ſpin their ſcarce imaginable fine web, and incloſe themſelves in oval balls of a very artificial figure and texture, ſhould have wrought thus by imitation; there not having been for many months before, in the place, where they were hatched (nor perhaps in the whole country) any ſilk-worms alive which they might imitate. But I muſt leave theſe curious ſpinſters to their work, and proceed to tell you, that ſeas and mountains, with the other hyperboles of nature (if I may ſo term them) proclaim indeed God's power, but do not perhaps more manifeſt his wiſdom, than the contrivance of ſome living engines, and (if I may ſo call them) breathing atoms, that are ſo ſmall, that they are almoſt all workmanſhip; ſo that, as before, in the Pſalmiſt's expreſſion we truly ſaid of God's greatneſs, *That it was unſearchable*; we may now as truly ſay of his wiſdom in the prophet's words, and in the ſame text where he repreſents him as the Creator of the ends of the earth, *That there is no ſearching of his underſtanding.* Iſa. xl. 28.

Of the eyes and feet of moles.

Of the ſilk-worm.

That it works by inſtinct, and not by imitation.

AND if I durſt, *Pyrophilus*, make this part of this eſſay of a length too diſproportionate to the reſt, I could eaſily, as well as willingly, repreſent to you divers things, which might ſerve to illuſtrate the πολυποικίλος σοφία τ῀ Θε῀, *manifold wiſdom of God* (as St. *Paul* ſpeaks on another occaſion:) but though I dare not expatiate on this ſubject, yet neither dare I altogether conceal from you, that I have ſometimes admired to ſee, what ſcarce imaginable variety of living engines his plaſtick ſkill (if I may ſo ſpeak) has been able to produce, (eſpecially in the waters) without ſcarce any other reſemblance betwixt them, than that they are each of them excellent in its own kind, and compleatly furniſhed according to the exigency of its nature. And that, which much encreaſes this wonder, is the diſproportion of thoſe living engines, wherein the great [*Yotzêer hakkôl*] *Former of all things* (as the ſcripture juſtly calls God) has been pleaſed to diſplay an almoſt equally ſkilful contrivance. Amongſt terreſtrial animals we have the elephant, of whoſe ſtupendous vaſtneſs ſuch ſtrange things are related, even by eminent writers, that I know not well how either to diſ-believe them, or give credit to them: and therefore we ſhall content our ſelves to mention that, which is left on record by the accurate *Gaſſendus* in the life of *Peireskius*. For this matchleſs gentleman having cauſed an elephant, in the year 1631, to be weighed in a ſcale, purpoſely provided, he was found to weigh, of the Roman pounds (conſiſting of twelve ounces a-piece) very near five thouſand. And yet ſurely that this elephant was very far from being one of the largeſt of that ſort of beaſts, he, that ſhall conſider the bigneſs and length of ſome of their teeth, as they are commonly called, which are to be ſeen at divers places, both in *England* and elſewhere, and is not reſolved not to believe the conſonant relations of Eaſtern travellers (among whom

Jer. x. 16.

Gaſſend. in Vit. Peireſkii, lib. 4. *Of the vaſtneſs of the elephant, and its diſproportion to the ἄνοῤῥοι, and ſuch like mites.*

whom *Linſchoten* tells us, there have been ſome teeth found to weigh two hundred pounds a-piece, each pound conſiſting of twenty-four ounces) may be eaſily perſuaded. On the other ſide, let us reflect upon the ſmallneſs of ſome terreſtrial animals; and not to mention that little white creature bred in wax, which *Ariſtotle* calls Ἄκαρι, and ſpeaks of as ſuppoſed to be the leaſt of all living creatures whatſoever; let us conſider thoſe little mites, that are bred in mouldy cheeſe; for divers of theſe ſcarce amount to the weight of a grain, and every pound containing five thouſand ſeven hundred and ſixty grains; ſuppoſing each mite did weigh a whole grain, yet that formerly mentioned ſmall elephant would exceed him near 28,800,000 times. And yet though a mite ſeem but a moving atom, and, unleſs there be divers together, is not eaſily diſcerned by the unaſſiſted eye; yet in an excellent microſcope, I have, you know, ſeveral times both ſeen and ſhewn to others, even in a gloomy day, and a diſadvantageous place, not only the limbs of this little animal, but the very hair growing upon his legs. Now let us but conſider, how ſtrangely ſkilful and delicate a workmanſhip muſt be employed to contrive into ſo narrow a compaſs the ſeveral parts internal and external, requiſite to make up this little animal; how many muſt go to the texture of the eyes, and other organs of ſenſe; how many to the ſnout (which he has, not unlike a hog) and the ſeveral parts of it; how many to the ſtomach and guts, and the other inward parts addicted to the digeſtion of aliment, and excluſion of excrements; and, to be ſhort, how unimaginably ſubtle muſt be the animal ſpirits running to and fro in nerves ſuitable in ſuch little legs: and if, as we have obſerved them to multiply by eggs, the little creatures be hatched in thoſe little eggs, after the manner of divers other oviparous animals, how much ſmaller than a hatched mite muſt be a mite upon the animation of its delineated parts? ſince in hen's eggs we have ſometimes ſeen the chick manifeſtly alive, and its limbs clearly delineated, whilſt yet it took up ſo ſmall a portion of the egg, that both the white and the yolk (betwixt which it is generated, and not of the chalaza or treadle, as *Aquapendente* and other moderns teach) ſeemed to be ſometimes yet intire, as well as involved in their peculiar membranes. But it is not ſo conſpicuous in gradient animals (if I may ſo ſpeak) as in ſwimming ones; how vaſtly diſproportionate maſſes of matter the wiſe Former of all things can faſhion into living engines. For whales are much more ſtupendous creatures than elephants: And not to mention what *Hartenius (apud Johnſtonum)* tells us of twenty ſorts of whales, whereof the eighteenth ſpecies, which he calls *Nordhwal* is by him related to be ninety ells long; but what ells he means, I know not: nor to mention thoſe leſs incredible accounts, which are given of the vaſtneſs of whales by our Engliſh navigators, who are wont to fiſh for them; I ſhall only ſet down what is related by one of the eminenteſt modern Lyncean philoſophers, becauſe he ſpeaks as an eye-witneſs, when he tells us, that in the year 1624, there was caſt upon a place near *Santa Severa*, about 30 miles from *Rome*, a dead whale of 91 palms in length, and 50 in thickneſs: he adds, that its mouth was 16 palms long, and ten high; in which, being opened and kept gaping, a man on horſe-back might find competent room; this mouth being uſed to harbour a tongue of twenty palms (which may make out fifteen foot) in length. The ſame inquiſitive writer adds, that four years before, near the iſland of *Corſica*, not far from the coaſt of *Italy*, another whale was caſt, one hundred foot long, which being a female, was found to be big with a cub of thirty foot long, 1500 pound weight. But that, which will let you ſee, *Pyrophilus*, the diſproportion betwixt theſe kind of fiſhes and common elephants, is that, which the ſame author adds, *that the lard only, or fat*, (as he ſpeaks, *carnea pinguedo*) *of this corpulent creature, weighed one hundred and thirty-five thouſand pound*; that is, above twenty ſeven times the weight of the whole elephant, which was cauſed to be weighed by *Peireſkius*. And though the omnipotent Creator be able to make ſwimming creatures of ſuch prodigious bigneſs, that the ocean itſelf may ſeem to be but a proportionate pond for ſuch fiſhes; yet is the ſame omniſcient continuer as able to make a ſwimming engine more ſlender than a cheeſe-mite, and ſo little, that the ſmall part of a grain may out-weigh divers of them. For, *Pyrophilus*, I muſt here acquaint you with a ſtrange obſervation, which I have been informed to have been ſome while ſince made in *Italy* by *Panarola* a famous phyſician in *Rome*, who is ſaid, by the help of an excellent microſcope, to have diſcerned in vinegar ſmall living creatures, which he takes to be worms. The mention of ſo unlikely an experiment made me ingage ſome excellent philoſophers and mathematicians to aſſiſt me in examining it: but though our microſcopes exceeded the beſt, that were brought us over from *Rome*, yet all our diligence and attention did but make them conclude, that *Panarola*'s eyes had been deluded. Notwithſtanding which, cauſing a ſomewhat hollow bottom of pure cryſtalline glaſs to be fitted to my microſcope, I proſecuted the enquiry myſelf; and at length was ſo lucky, as not only to diſcover theſe little creatures with a microſcope, but by holding the liquor in a cryſtal phial, almoſt upon the ſtrong flame of a candle, to diſcover multitudes of them with my naked eyes, as weak as they are. But though I have already convinced thoſe, that formerly derided ſuch obſervations, as not to be made with the beſt microſcope, yet the great weakneſs of my ſight has not permitted me to perfect my obſervations concerning theſe creatures. And therefore reſerving the more particular mention of this odd obſervation till another time, I ſhall now only tell you as much as is pertinent to our preſent purpoſe; namely, that having with a certain parcel of ſtrong white-wine vinegar (for it is not in every vinegar, that they are conſtantly to be found) filled up to the top thin phials, with long and ſlender necks; and having likewiſe with the ſame liquor filled other ſmall cryſtalline phials, though ſhort-necked, and held them

Of the vaſtneſs of the whale, and its diſproportion to the ſmall worms or fiſhes lately diſcovered in vinegar.

* Jo. Faber. Lynceus *in his expoſition of ſome paſſages of* p. 568.

them betwixt my eye and the ſun, or a window open towards it, or very near a great candle, I have often in theſe glaſſes, eſpecially in their ſlender necks, after having a while fixed my eye on them, (attention being in this caſe very neceſſary) admiringly obſerved great numbers (and ſometimes as it were ſhoals) of living creatures, which ſeemed to be rather fiſhes than worms; for they ſwim freely up and down the liquor, and often hover about the top of it with a wriggling motion, like that of eels, to which likewiſe their long and ſlender ſhape reſembles them. And though theſe ſwimming creatures be not all exactly of a ſize, yet ſome of them ſeemed ſlenderer than any ſort of living ones, that hath hitherto been taken notice of by the unaſſiſted eye. And I remember, that having looked in a good microſcope upon one of them, and a cheeſe-mite, much about the ſame time, the fiſh appeared ſo ſlender, that we judged it not much thicker than one of the legs of the mite: ſo that conſidering what a vaſt deal of matter the great Creator can manage and faſhion into a whale, and in how little room he can contrive all the parts requiſite to conſtitute a fiſh, we may juſtly ſay to him in the Pſalmiſt's language, *there is none like unto thee (O Lord) neither are there any works like unto thy works.*

Pſalm lxxxvi. 8.

How God's goodneſs is conſpicuous in his creatures by his proviſion of accommodations for them all, but eſpecially for his favourite, man.

THE laſt of the three properties of God, which we mentioned him to have manifeſted in the creation, is his goodneſs; of which all his creatures do in their due meaſure partake, partly by their having a being vouchſafed them, and partly by their being preſerved in it, as long as their ſubordination to higher purpoſes, and to more powerful creatures do permit, by that ſupporting influence of God, which keeps them from relapſing into their firſt nothing; according to that memorable paſſage, where *Nehemiah* having mentioned God as the *Creator of the heavens, the earth, the ſeas, and all the creatures belonging to them*, he calls him the *Preſerver*, or (as the original has it) *the Enlivener of them all.* And as for animals, who are more capable of enjoying, though not moſt of them of diſcerning his bounty, his goodneſs to them is more conſpicuous. For beſides that in ſcripture he is called the *Preſerver both of man and beaſt*, and accordingly is ſaid to *give food even to the young ravens that cry*, and to have, after the *flood*, remembered not only *Noah*, but *every living thing that was with him in the ark*; his goodneſs to them is apparent, by the plentiful and eaſily attainable proviſion he makes according to the exigence of their ſeveral natures, for that innumerable ſwarm of various birds, beaſts, fiſhes, reptiles, and other animals, that people the terreſtrial globe, and the contiguous parts of the world, and by his endowing each of them with all the qualifications requiſite to the perpetuation of their ſpecies, and the preſervation of their lives, as far forth as is conſiſtent with his ends in their creation. But moſt reſplendent does the goodneſs of God appear towards his favourite creature, man, whom having vouchſafed to ennoble with his own image, he makes moſt of the creatures of the world viſible to us, pay homage to him, and in ſome manner or degree do him ſervice; God's liberality at once beſtowing on him all thoſe creatures, by endowing him with a reaſon enabling him to make uſe of them; ſo that even thoſe creatures, which he is not able to ſubdue by power, he is able to make ſerviceable to him by his knowledge: as thoſe vaſt globes of light, which are ſo far above him, that their immenſity and brightneſs can ſcarce render them viſible to him, are by man's mathematicks forced to give him an account of all their motions, and waiting upon his dials keep time for him; and even the defects of ſuch works of nature are by man's ſkill made ſerviceable to him, as the eclipſes of the moon ſerve geographers notably in that difficult and uſeful work of finding longitudes. The ſtars ſerve for candles to give man light, and the celeſtial orbs are his candleſticks. He breathes the air, the fire warms him, and ſerves him not only in his kitchen, but to maſter moſt other bodies in his furnaces. The clouds water his land, the earth ſupports him and his buildings, the ſea and winds convey him and his floating houſes to the remoteſt parts of the world, and enable him to poſſeſs every where almoſt all that nature or art has provided for him any where. The earth produces him an innumerable multitude of beaſts to feed, clothe, and carry him; of flowers and jewels to delight and adorn him; of fruits, to ſuſtain and refreſh him; of ſtones and timber, to lodge him; of ſimples, to cure him; and in ſum, the whole ſublunary world is but his magazine. And it ſeems the grand buſineſs of reſtleſs nature ſo to conſtitute and manage his productions, as to furniſh him with neceſſaries, accommodations, and pleaſures.

Nehem. ix. 6.

Gen. viii. 1.

OF ſuch a number of plants, animals, metals, minerals, *&c.* that people and enrich the terreſtrial globe, perhaps there is not any one, of which man might not make an excellent uſe, had he but an inſight into its nature: nor are the moſt abject and deſpicable therefore the leaſt uſeful. There is not any ſtone, no not the ſparkling diamond it ſelf, to whom man is ſo much beholden, as he is to the dark and unpromiſing load-ſtone; without which the new-world probably had never been detected, and many regions of the old world would have little or no commerce with each other. Nor have the lion, the eagle, and the whale joined all together, (though reputed the chief of birds, beaſts, and fiſhes) been ſo ſerviceable to man, as that deſpicable inſect, the ſilk-worm. And if we impartially conſider the lucriferouſneſs (if I may ſpeak in my Lord of *St. Alban*'s ſtyle) of the properties of things, and their medical virtues, we ſhall find, that we trample upon many things, for which we ſhould have cauſe to kneel, and offer God praiſes, if we knew all their qualities and uſes. But of this ſubject we may elſewhere purpoſely treat.

Of the unknown and new detected properties and virtues of divers concretes.

TO which I muſt only add, *Pyrophilus*, that you will injure nature, if you ſuppoſe, either that all the concretes, endowed with excellent properties, have long ſince been notorious; or that all the medicinal virtues of ſimples, commonly uſed, are already known; or

that all thoſe concretes are deſtitute of conſiderable properties, to whom none have been yet aſcribed by eminent authors. For almoſt every day either diſcloſes new creatures, or makes new diſcoveries of the uſefulneſs of things; almoſt each of which hath yet a kind of *terra incognitâ*, or undetected part in it. How many new concretes, rich in medicinal virtues, does the new world preſent the inquiſitive phyſicians of the old? *Notatu dignum* (ſays the ingenious *Piſo*, in his new publiſhed *Medicina Braſilienſis*, *lib.* 1.) *quod eximiæ tot arbores, frutices, & innumeræ herbæ, figura, foliis, & fructibus à veteris orbis vegetabilibus, paucis exceptis, diſſimillimæ appareant. Inde de avibus, animantibus, & piſcibus deprehenditur, ut & inſectis alatis, atque alis deſtitutis, quæ ineffabili colorum pulchritudine & portentoſa multitudine generantur, partim nota nobis, partim incognita:* 'It is obſervable, that ſo many excellent trees, ſhrubs, and an innumerable company of herbs, ſome few excepted, ſhould all appear ſo unlike the vegetables of the antiently known world, both in figure, leaf, and fruits: and the ſame obſervation is made of birds, beaſts, and fiſhes; and of inſects both flying and creeping, which are monſtrouſly numerous, and of unſpeakable beauty in colour, ſome known to us, and ſome unknown.' And of the known American ſimples, how many latent virtues does experience from time to time diſcover? And (to mention now no others) the febrifugal property of that Peruvian tree, called by the natives *Gannanaperide*, whoſe bark, called commonly *China febris*, has been at *Rome*, and freſhly alſo at *London*, found ſo wonderfully effectual againſt thoſe ſtubborn diſeaſes, quartan agues; and though a learned author endeavours to depreciate it, by alledging, that it is wont rather to ſuſpend the fits, than truly cure the diſeaſe, which after a while will return again; yet, beſides that it may be often very beneficial to a weakened patient to have his fits put off, the phyſician thereby alſo gaining opportunities to imploy ſtrengthening and preventing remedies; beſides this, I ſay, if you will credit that great perſon, Sir *Kenelm Digby*, it is rather the patient's or doctor's fault, than the medicine's, if the diſeaſe return. For having purpoſely conſulted him about this objection againſt the uſe of the *cortex febrifugus*, he ſolemnly aſſured me, that of betwixt twenty and thirty perſons, that he had himſelf cured of quartans by this remedy, not ſo many as two fell into a relapſe.

Of the Peruvian bark, commonly called the Jeſuits powder.

AND now I am upon the more freſhly diſcovered virtues of American drugs, I might acquaint you with the admirable properties, not only in diſeaſes, but even in wounds, of a certain mineral, which (though careful examination of it has not yet taught me, to what ſpecies of ſtones to reduce it) you cannot but have heard mentioned with wonder, under the name of Sir *Walter Raleigh*'s ſtone, which my father, ὁ μαχαίτης, enjoyed, and did ſtrange things with for many years, and by his will bequeathed (as the higheſt legacy he could leave him) to his deareſt friend, the moſt learned and famous Bp. *Uſher*, Primate of *Ireland*. But of this ſtone, the merit of the ſubject makes me reſerve what I have to ſay, to a diſcourſe, wherein I may be allowed to ſay more to it than now I dare: and therefore I ſhall proceed to tell you, that it is not in the ſimples of the new world only, that new medicinal properties may be diſcovered; for even thoſe, which daily obtrude themſelves upon our careleſs eyes, or are trampled under our regardleſs feet, may poſſeſs virtues, to which the major part of botaniſts are mere ſtrangers. To which purpoſe I remember, that I have often gathered a little ſhort-lived and deſpicable plant, (namely *Paronychia folio rutaceo*) with which alone (ſlightly infuſed in beer) I lately knew a young kinſman of Sir *Kenelm Digby*'s, in few days, and without pain, as both himſelf, his mother, and his phyſician aſſured me, cured of that ſtubborn and ſeldom vanquiſhed diſeaſe of the king's evil, againſt which it doth wonders: and yet having conſulted not only ſome of the famouſeſt and recenteſt herbals, both Engliſh and Latin, about this, but alſo enquired of two or three eminent herbariſts, I could find neither any ſuch virtue, nor almoſt any at all, aſcribed by authors to that excellent plant.

Of the uſe of Paronychia fol. rutaceo *in the king's-evil, and of divers other concretes obſervable for their unknown properties.*

AND whereas God's bounty to man in the creatures ſeems a little clouded and ſtreightened by his permitting ſome poiſonous plants and venomous animals to have a being in nature; to that it may be replied, firſt, that many poiſonous bodies contain their own antidotes; inſomuch that the diligent *Piſo*, who hath had great opportunities to examine the effects of both, ventures to ſay, treating of the poiſons and antidotes to be met with in *Braſil*, *Equidem vix dixeris, venena an Alexiteria plura ſint pronata.* And a little lower, *Sic folia, flores, & fructus herbarum Tangaraca & Juquerii, venena Braſiliæ facilè prima, propriam ſuam unaquæque radicem oppoſitum habet antidotum.* And a little after, *Barbari viperarum pinguedinem & capita, tum & integra inſecta, quæ vulnera intulerint, ex arte parata, audaciter & felici cum ſucceſſu venenatis ictibus applicant; adeoque per ipſos effectus comprobare nituntur in omni veneno contineri ſuam antidotum:* 'You can ſcarce determine, whether in theſe countries there are found more poiſons or antidotes: the leaves, flowers, and fruits of the herbs Tangarack and Juquer, the two moſt potent venoms of *Braſil*, each of theſe hath its proper root for an oppoſite antidote. The Barbarians apply the fat and heads of vipers, and the whole bodies of thoſe inſects, prepared according to art, that ſtung or ſtuck any perſon, and that with boldneſs and happy ſucceſs, to the wounds made by them, and ſo by the effects do attempt to prove, that in every venom its own antidote is contained.' And next, that the noxiouſneſs of many (and therefore not improbably of all of them) is not ſo incorrigible, but that by man's art and chymical preparations, they may be made, not only innocent and harmleſs, but uſeful too. This truth, *Pyrophilus*, antimony and quickſilver, and ſome other noxious bodies (which men have learned to make medicinal) have already taught our modern

Of the uſe of divers noxious concretes, and that they contain their own antidotes.

modern phyſicians; who preſcribe, even in their diſpenſatories, divers medicines made out of thoſe churliſh minerals, to which in the enſuing diſcourſes you will find divers others (perhaps not inferiour) added. That opium is reckoned by phyſicians among poiſons, I need not tell you; and yet ſuch powerful remedies may be made with it for many deſperate caſes, eſpecially in hot countries, that the good it may do, ſo much exceeds the harm, that phyſicians would be ſorry there were none of it in the world. The oil of ſcorpions is not only antidotal againſt their ſtings, but is witneſſed by experience, to be very uſeful to bring away the deſcending ſtone of the kidneys, and to remedy divers other miſchiefs, beſides thoſe, that ſcorpions can do. And to theſe I ſhall need but to add one inſtance more, becauſe of the nobleneſs of that ſingle one, and that is the root *Mandihoca*, ſo common all over the *Weſt-Indies*: for nature is ſo far from having been a ſtep-mother to man, in making that plant abound ſo much in thoſe countries, though in its crude ſimplicity (as the Helmontians ſpeak) it be confeſſedly a rank poiſon, that ſhe hath ſcarce in any one plant been ſo bountiful to the Americans. For by a ſlight and eaſy preparation, which we ſhall hereafter mention, it affords many populous nations almoſt all the bread they eat, and ſome of them a good part of their drink; the root freed by a ſtrong preſs from the noxious juice, and dried, affording them that Caſſavy meal, whereof they make their bread; which by the taſte and colour I could not diſcern to be other than good. Nor is this the only uſe this poiſonous plant affords them; for the above-commended *Piſo* gives us this ſhort, but comprehenſive character of it; *Ex Mandihoca radice maximo ſcatente veneno, optimum alimentum non ſolùm, ſed & antidotum concinnatur*, (lib. 3.) 'From the root Mandi-'hoca, that abounds with a very potent poi-'ſon, there is made not only excellent aliment, 'but even antidote too.' But concerning the uſe, that may be made of poiſonous creatures, we elſewhere profeſſedly diſcourſe; and ſhall therefore now proceed to obſerve to you here, that I have not yet mentioned to you the inſtance, which moſt manifeſts the greatneſs of the good, which God intended man in the creatures. For, not content to have provided him all, that was requiſite either to ſupport or accommodate him here, he hath been pleaſed to contrive the world ſo, that (if man be not wanting to himſelf) it may afford him not only neceſſaries and delights, but inſtructions too. For each page in the great volume of nature is full of real hieroglyphicks, where (by an inverted way of expreſſion) things ſtand for words, and their qualities for letters. The Pſalmiſt obſerves, *That the heavens declare the glory of God:* and, indeed, they celebrate his praiſes, though with a ſoundleſs voice, yet with ſo loud a one (and which gives us the moral of *Plato*'s exploded notion of the muſick of the ſpheres) to our intellectual ears, that he ſcruples not to affirm, that *there is no ſpeech nor language, where their voice is not heard*, (or as *Junius* and *Tremellius* render it, without violence to the Hebrew text, *there is no ſpeech nor words, yet without theſe their voice is underſtood) and that their line is gone throughout all the earth:* that is (as the learned *Diodati* expounds it) their writing in groſs and plain draughts, and their words to the end of the world; their language having ſo eſcaped the confuſion of tongues, that theſe natural and immortal preachers give all nations occaſion to ſay of them, as the aſſembly at pentecoſt did of the inſpired Apoſtles, *we do hear them ſpeak in our tongues the wonderful works of God.* Acts ii. 11.

Of that excellent Weſt-Indian root Mandihoca.

How we are by the creatures inſtructed to devotion. Pſal. xix. 1.

NOR can we, without liſtening to theſe ſermons, derive the entire (perhaps not the chiefeſt) benefit deſigned us in the creatures. For ſure that God, who hath compoſed us both of body and ſoul, hath not confined the uſes of ſo many admirable creatures, and ſo much inimitable workmanſhip, to that ignoble part of man, which coupleth him to the beaſts, with the neglect of that diviner portion, which allies him to the angels; vouchſafing to the lord of the creatures, in the fruition of this his palace, no higher prerogative, than he is pleaſed to allow to the brutes, that ſerve but to complete the variety requiſite for its embelliſhment. Of this opinion I lately found that excellent writer, St. *Auſtin*, to have been before me: For, *Non debes uti oculis* (ſays he) *ut pecus, tantum ut videas, quæ addas ventri, non menti: utere, ut homo, intende cœlum, & intende facta, & quære factorem; aſpice quæ vides, & quære quem non vides, crede in eum quem non vides, propter iſta quæ vides. Nolite fieri ſicut equus & mulus, &c.*

'You ought not to uſe your eyes as a brute,
'only to take notice of proviſions for your bel-
'ly, and not for your mind: uſe them as a
'man; pry up into heaven; ſee the things made,
'and enquire the Maker; look upon thoſe
'things you can ſee, and ſeek after him, whom
'you cannot ſee, and believe on him you can-
'not ſee, becauſe of thoſe things you ſee: and
'be not like the horſe and mule, *&c.*'

NOR can the creatures only inform man of God's being and attributes (as we have already ſeen) but alſo inſtruct him in his own duties; for we may ſay of the world, as St. *Auſtin* did of the ſacraments, that it is *verbum viſibile*. And certainly, God hath never ſo confined himſelf to inſtruct men by words or types, as not to reſerve himſelf the liberty of doing it by things: witneſs his appointing the rainbow to preach his goodneſs to all nations, and fortify the faith of mankind againſt the fear of a ſecond deluge. It is ſomething too high a ſaying for an heathen, that of *Plato*, where he teaches, *That the world is God's epiſtle, written to mankind.* For by *Solomon* God ſends the *ſluggard to ſchool to the ant*, to learn a provident induſtry. Chriſt commands his diſciples to *learn of ſerpents and pigeons* prudence and inoffenſiveneſs. The ſame divine teacher enjoins his apoſtles to *conſider the lillies*, or (as ſome would have it) the *tulips of the field*, and to learn thence that difficult virtue of a diſtruſtleſs reliance upon God. And St. *Paul* ſeems almoſt angry with the Corinthians, that their faith, in ſo abſtruſe myſteries as that of the reſurrection, was not informed and ſtrengthened, by conſidering

D. Aug. Hom. 3.

1 Cor. xv. 36, 37.

ſidering the meliorating death of corn committed to the earth. And the royal poet learns humility, by the contemplation of the moſt elevated parts of nature; *When I conſider* (ſays he) *the heavens, the work of thy fingers, the moon and ſtars, which thou haſt ordained, what is man, that thou viſiteſt him?* Thus you may ſee, that God intended the world ſhould ſerve man, not only for a palace to live in, and to gaze on, but for a ſchool of virtue, to which his philanthropy reſerves ſuch ineſtimable rewards, that the creatures can on no account be ſo beneficial to man, as by promoting his piety; by a competent degree of which, God's goodneſs hath made no leſs than eternal felicity attainable.

Pſal. viii. 3, 4

ESSAY III.

Containing a Continuation of the former.

That their opinion, who would deter men from the ſcrutiny of nature, tends to defeat God of much of that glory man ſhould aſcribe unto him.

HAVING thus, *Pyrophilus*, endeavoured to evince, that the opinion, that would deter men from the ſcrutiny of nature, is not a little prejudicial to man's intereſts, and does very much leſſen the advantages he may derive from the creatures, both in relation to his accommodation in this life, and his felicity in the next; let us proceed to conſider, whether the doctrine we oppoſe do not likewiſe tend, in its own nature, (though not in the intentions of its patrons) to defeat God of much of that glory, which man both ought and might aſcribe to him, both for himſelf and the reſt of the creatures. How unlikely it is, that we ſhould be able to offer to God that glory, praiſe, and admiration, he both expects and merits from ſuch a contemplation of the creatures, as, though it be requiſite to the true knowledge of their nature and properties, is yet ſuppoſed either pernicious, or at leaſt dangerous; you, *Pyrophilus*, or any other impartial perſon may eaſily determine.

FOR the works of God are not like the tricks of jugglers, or the pageants, that entertain princes, where concealment is requiſite to wonder; but the knowledge of the works of God proportions our admiration of them, they participating and diſcloſing ſo much of the inexhauſted perfections of their author, that the further we contemplate them, the more foot-ſteps and impreſſions we diſcover of the perfections of their Creator; and our utmoſt ſcience can but give us a juſter veneration of his omniſcience. And as when ſome country fellow looks upon a curious watch, though he may be hugely taken with the rich enamel of the caſe, and perhaps with ſome pretty landſkip that adorns the dial-plate; yet will not his ignorance permit him ſo advantageous a notion of the exquiſite maker's ſkill, as that little engine will form in ſome curious artiſt, who beſides that obvious workmanſhip, that firſt entertains the eye, conſiders the exactneſs, and knows the uſe of every wheel, takes notice of their proportion, contrivance, and adaptation all together, and of the hidden ſprings, that move them all: ſo in the world, though every peruſer may read the exiſtence of a Deity, and be in his degree affected with what he ſees, yet he is utterly unable to deſcry there thoſe ſubtler characters and flouriſhes of omniſcience, which true philoſophers are ſharp-ſighted enough to diſcern. The exiſtence of God is indeed ſo legibly written on the creatures, that (as the Scripture ſpeaks in another ſenſe) *He may run, that reads it*; that is, even a perfunctory beholder, that makes it not his buſineſs, may perceive it: but that this God hath manifeſted in theſe creatures a power, a wiſdom, and a goodneſs worthy of himſelf, needs an attentive and diligent ſurveyor to diſcover. How different notions of God's wiſdom do the eggs of hens produce in the ordinary eaters of them, and in curious naturaliſts, who carefully watch, and diligently obſerve, from time to time, the admirable progreſs of nature in the formation of a chick, from the firſt change appearing in the *cicatricula* (or little whitiſh ſpeck diſcernible in the coat of the egg's yolk) to the breaking of the egg-ſhell by the perfectly hatched bird; and on nature's exquiſite method in the order and faſhioning of the parts, make ſuch philoſophical reflections, as you may meet with (not to mention what *Ariſtotle* and *Fabricius ab Aquapendente* have obſerved on that ſubject) in the ingenious treatiſe of generation, which our accurate and juſtly famous anatomiſt, Dr. *Highmore*, has been pleaſed to dedicate to me; and in the excellent Exercitations *De Ovo* of that great promoter of anatomical knowledge, Dr. *Harvey*. And whereas it may be alledged, that the attributes of God, which are not taught us, but after much ſpeculation of the world, are things, of which no man but an atheiſt doubts; to this it may be replied, that beſides that it ill becomes the ſenſe we ought to have of our weakneſs to deſpiſe any helps vouchſafed us of God to aſſiſt us to know or ſerve him; beſides this, I ſay, God loving, as he deſerves, to be honoured in all our faculties, and conſequently to be glorified and acknowledged by the acts of reaſon, as well as by thoſe of faith, there muſt be ſure found a great diſparity betwixt that general, confuſed, and lazy idea we commonly have of his power and wiſdom, and the diſtinct, rational, and affecting notions of thoſe attributes, which are formed by an attentive inſpection of thoſe creatures, in which they are moſt legible, and which were made chiefly for that very end. The queen of *Sheba* had heard in her own country a very advantageous fame of the wiſdom of *Solomon*; but when the curioſity of a perſonal viſit made her an eye-witneſs of thoſe particular both exquiſite ſtructures,

Hab. ii. 2.

and almoſt divinely prudent conducts and contrivances, wherein that wiſdom did inimitably diſplay it ſelf, ſhe then brake forth into pathetick and venerating exclamations, that acknowledged how much juſter and improved a character (of his wiſdom) her eyes had now given her, than formerly her ears had done.

VERY like a philoſopher, methinks, does the great *Mercurius Triſmegiſtus* (if we grant him to be the author of the books aſcribed to him) ſpeak, when he tells his ſon, 'There 'can be no religion more true or juſt, than to 'know the things that are, and to acknowledge thanks for all things to him, that made 'them; which things I ſhall not ceaſe to do.' He continues 'Be pious and religious, O my 'ſon! for he, that does ſo, is the beſt and 'higheſt philoſopher; and without philoſophy, 'it is impoſſible ever to attain to the height 'and exactneſs of piety and religion.' And it was perhaps, *Pyrophilus*, to engage us to an induſtrious indagation of the creatures, that God made man ſo indigent, and furniſhed him with ſuch a multiplicity of deſires; ſo that whereas other creatures are content with thoſe few obvious and eaſily attainable neceſſaries, that nature has almoſt every where provided for them; in man alone, every ſenſe has ſtore of greedy appetites, for the moſt part of ſuperfluities and dainties, that to relieve his numerous wants, or ſatisfy his more numerous deſires, he might be obliged with an inquiſitive induſtry to range, anatomize, and ranſack nature, and by that concerned ſurvey come to a more exquiſite admiration of the omniſcient Author. To illuſtrate this ſubject yet a little further, *Pyrophilus*, give me leave to obſerve to you, that philoſophers of almoſt all religions have been, by the contemplation of the world, moved to conſider it under the notion of a temple: *Ne adoremus* (ſays *Plutarch*) *elementa, cœlum, ſolem, lunam, &c. ſpecula ſunt hæc, in quibus artem illius ſingularem intueamur, qui mundum condidit, & adornavit; nec eſt alius mundus quàm templum ejus:* 'Let us not venerate the ele-'ments, the heaven, the ſun, the moon, &c. 'theſe are but mirrors, wherein we may be-'hold his excellent art, who framed and adorned the world; nor is the world any thing elſe 'but his temple.' *Homines* (ſays *Cicero*) *tuentur illum globum, quem in templo hoc medium vides, qui terra dicitur:* 'Men abide upon that 'globe, which you ſee in the middle of this 'temple, and is called the earth:' which *Macrobius* handſomely thus expounds; *Quicquid humano aſpectui ſubjicitur, templum ejus vocavit, qui ſola mente concipitur, ut qui hæc veneratur ut templa, cultum tamen maximum debeat Conditori, ſciatque quiſquis in uſum templi hujus inducitur, ritu ſibi vivendum ſacerdotis:* 'All that 'human view reaches, he terms his temple, 'who is apprehended by the mind alone; to 'the end, that whoſo reverences theſe things 'as temples, might render the greateſt wor-'ſhip to the Maker: and every one, that is 'brought to converſe in this temple, might 'know himſelf obliged to live like a prieſt.'

Merc. Triſm. l. 1. Engliſhed by Dr. Everard.

That philoſophers of all religions have conſidered the world under the notion of God's temple.

AND the lofty *Seneca* (to mention now no other Heathens) in divers paſſages of his excellent writings, ſtyles the world a temple; and I remember, in his treatiſe *De Beneficiis*, he avers in terms not unworthy his mind or his ſubject, *Totum mundum deorum eſſe immortalium templum, ſolum quidem amplitudine illorum ac magnificentia dignum:* 'That the whole world is 'the temple of the immortal gods, being 'alone worthy of their grandeur and magni-'ficence.' The aſſent of the Jewiſh philoſophers to this notion you may be pleaſed to receive from their eloquent *Philo*, who not only gives the world the name of temple, but gives us this account of that appellation; *Templum Dei ſupremum & verè tale exiſtimare totum hunc mundum, qui ſacrarium quidem habet, puriſſimam rerum naturæ partem, cœlum; ornamenta, ſtellas; ſacerdotes, adminiſtros potentiæ ejus, angelos, & incorporeas animas:* 'The whole 'world is to be accounted the chiefeſt temple 'of God; the *Sanctum Sanctorum* of it is of the 'pureſt part of the univerſe, heaven; the 'ornaments, the ſtars; the prieſts, the mini-'ſters of his power, angels, and immaterial 'ſouls.' And as for Chriſtian philoſophers, I ſuppoſe it would be needleſs to enumerate the paſſages, wherein they adapt the notion of the world already mentioned; and therefore I ſhall content my ſelf to add, that the ſcripture it ſelf ſeems to authoriſe it by repreſenting to us, in the eighth or ninth chapters of the epiſtle to the Hebrews, the Moſaical tabernacle, as an adumbration of that great temple of the world; and particularly there is a ſignal text in the latter of thoſe chapters, where it is ſaid, that Chriſt is not entered into holy places made with hands [χειροποίητα ἅγια] which are copies of the true, [ἀντίτυπα τῶν ἀληθινῶν] but into heaven it ſelf, now to appear in the preſence of God for us.

Templum Dei ſupremum & verè tale exiſtimare totum hunc mundum, qui ſacrarium quidem habet, puriſſimam rerum naturæ partem, cœlum; ornamenta, ſtellas; ſacerdotes, adminiſtros potentiæ ejus, angelos, & incorporeas animas: Philo Jud. de Monarchia.

Heb. viii. 2, 5.

Heb. ix. 24.

UPON what account, *Pyrophilus*, I eſteem the world a temple, I may elſewhere have occaſion to declare; but this for the preſent: it will not be raſh to infer, that if the world be a temple, man ſure muſt be the prieſt, ordained (by being qualified) to celebrate divine ſervice not only in it, but for it. For as in ſchools, when the prince or ſome munificent benefactor confers ſome large poſſeſſion or rich annuity upon the foundation, though all the boys be concerned in the benefit, yet becauſe moſt of them are too young to be ſenſible of it, or too unlearned to be able to make the retribution of a handſome acknowledgment, either the maſter, or that other perſon of ſociety, who is moſt capable and the beſt ſpokeſman, is by a kind of natural right engaged to the duty of returning praiſe and thanks, not for himſelf alone, but in the name of all the reſt; ſo in the world, where there are ſo many inanimate and irrational creatures, that neither underſtand, how much they owe to their Creator, by owing him even themſelves, nor are born to a condition enabling them to acknowledge it; man, as born the prieſt of nature, and as the moſt obliged and moſt capable member of it, is bound to return thanks and praiſes to his Maker, not only for himſelf, but for the whole creation. In which ſenſe we may reconcile thoſe two current aſſertions, *That God made all things for his own glory,*

That in this temple man muſt be the prieſt.

glory, and that God made all things for man, and man for himſelf. Since whether or no man be a microcoſm or little world in *Paracelſus*'s ſenſe, if not as a reſembler, yet as a repreſenter of the macrocoſm or great world, he preſents with his own adorations the homages of all the creatures to their Creator, though they be ignorant of what is done, as infants under the law were of the ſacrifices offered on their account. And in this relation may the creatures anſwer the ſolemn invitation made them in the whole 148th Pſalm, and numerous other ſcriptures; which they may do (to borrow a barbarous, but ſignificant ſchool-term) objectively, though not formally; I mean, by proving occaſions, though not ſingers, of his praiſes; being ſuch objects, as prompt and invite man to pay God that praiſe upon their ſcore, which they cannot actually pay him themſelves; even God's muteſt works being capable of being ſaid to praiſe him in the ſame ſenſe (though in an incomparably tranſcendenter degree) that *Solomon* ſays of his virtuous woman (in the laſt verſe of the Proverbs) *Let her own works praiſe her in the gates*; that is, give the conſiderers of them occaſion to extol her: and thus by man's referring the knowledge of the creature to the Creator's glory, it becomes in ſome ſenſe, and congruouſly to its own nature, the praiſer of its maker, as may ſeem intimated in this oeconomy of the laſt part of one of the Pſalms, *Bleſs the Lord, all ye his hoſts, the miniſters of his, that do his pleaſure. Bleſs the Lord, all his works, in all places of his dominion: bleſs the Lord, O my ſoul.* Where, by ſhutting up the reſt of God's creatures betwixt angels and man's ſoul, he ſeems to inſinuate, that the irrational creatures bleſs the Lord by the mouth of thoſe, that are intelligent.

Prov. xxxi. 13.

Pſal. ciii.

The contemplation of God's mercy ought not ſo to ingroſs our thoughts, as to make us neglect the glory of his power and wiſdom.

AND truly, *Pyrophilus*, I fear it may reliſh a little of ſelfiſhneſs, to make ſuch a diſparity betwixt perfections, all of them equal, becauſe all of them infinite, as to let God's mercy, becauſe it moſt advantages us, ſo to ingroſs our thoughts and wonder, as to make us neglect the contemplation of thoſe other glorious attributes, his power and his wiſdom, which were thoſe, that exacted both man and angels adoration, before ſin gave occaſion to the exerciſe of the firſt. And I ſhall not ſcruple to confeſs unto you, that I dare not confine the acts of devotion to thoſe, which moſt men ſuppoſe to comprize the whole exerciſe of it: not that I at all undervalue, or would depreciate any, even the meaneſt practices of devotion, which either Scripture, or reaſon conſonant to it, recommends; but that I eſteem, that God may be alſo acceptably (and perhaps more nobly) ſerved and glorified by our entertaining of high, rational, and, as much as our nature is capable of, worthy notions, attended with a profound and proportionable admiration of thoſe divine attributes and prerogatives, for whoſe manifeſting he was pleaſed to conſtruct this vaſt fabrick.

To which purpoſe I conſider, that in the life to come, when we ſhall queſtionleſs glorify God exactlieſt, we ſhall have little either need or uſe of faith, prayer, liberality, patience, and reſembling graces; but our worſhip will chiefly conſiſt in elevated notions, and a proſtrate veneration of God's omnipotence, wiſdom, goodneſs, and other perfections; and ſuch a one as this is repreſented in the *Apocalypſe*, to be the preſent imployment of the bleſſed ſpirits in heaven, where the elders, that aſſiſt about the throne of God, are deſcribed caſting their crowns before it, and ſaying to him, that ſits on it, *Thou art worthy, O Lord, to receive glory, and honour, and power: for thou haſt created all things, and for thy pleaſure they are and were created.* Rev iv. 11.

BY this time, *Pyrophilus*, I hope you begin to think, that the doctrine, that tends to deter men from inquiring into nature, is as well derogatory from God's glory, as prejudicial to man's intereſts. And indeed, I purpoſed to content myſelf with the having diſperſed, throughout the paſt diſcourſe the grounds of anſwering their objection againſt the ſtudy of phyſiology, who pretend it is apt to make men atheiſts: but becauſe I am much concerned to have you ſatisfied of ſo important a truth, as that, which we have hitherto been labouring to evince, I muſt beg your leave, *Pyrophilus*, to add *ex abundanti* (as they ſpeak) to what has been already alledged, ſome things, that may more directly anſwer the objection of our adverſaries, and manifeſt, how little their ſeverity is befriended, either by Scripture, reaſon, or experience.

AND firſt, it ſeems not at all probable, that if the omniſcient Author of nature knew, that the ſtudy of his works did really tend to make men diſbelieve his being or attributes, he would have given men ſo many invitations, and almoſt neceſſities, to ſtudy and contemplate the nature of his creatures. Of theſe invitations divers have been mentioned already, and more might be added to them, if we thought it requiſite. But what has been above alledged, will make us forbear the annexing of any, ſave that of the ancient inſtitution of the ſabbath, which many eminent divines do not groundleſly hold to have been ordained to commemorate the creation, and give men the opportunity every ſeventh day to contemplate God in his works, as he himſelf was pleaſed to reſt on the firſt ſeventh day, and contemplate himſelf in the works of the firſt ſix. And though our weſtern churches, for certain reaſons (not here to be inquired into) have long ſince diſuſed the ſolemnizing of the Saturday, and appointed the Sunday for the celebration of both the works of the redemption, and creation of the world together; yet it is evident enough, that the primitive Chriſtians did for the moſt part keep the Saturday as holy-day, as well as the Sunday: for that ancient book (whoever be reſolved to have written it) which goes under the name of *Clement's Conſtitutions*, affords us, among others, theſe two memorable paſſages to our purpoſe: and firſt, Τὸ Σάββατον μέντοι (ſays he) ἡμῖν τὴν κυριακὴν ἑορτάζετε, ὅτι τὸ μὲν δημιουργίας ἐστὶν ὑπόμνημα, ἥδε ἀναστάσεως. *Keep the ſabbath and the Lord's day as holy days; that being dedicated to the remembrance of the creation, and this to that of the redemption.* To which we ſhall add this ſecond paſſage of the ſame author,

Proved further from the ancient inſtitution of the Sabbath.

Lib. vii. c. 24.

Ἐργα-

Ἐργαζέσθωσαν οἱ ἕξ λοι, &c. *Let ſervants work for five days; but on the ſabbath, and the Lord's day, let them attend in the church the doctrine of godlineſs.* To which purpoſe, I remember the moſt learned *Grotius* obſerves, that the converted emperor *Conſtantine* forbad the compelling Chriſtians to appear before tribunals on either of thoſe days, as being their feſtivals: Nay, and if modern travellers do not miſ-inform me, I find, that divers of the eaſtern churches, particularly the * Abyſſine Chriſtians, to this day, do as well ſanctify the ſabbath-day in commemoration of God's having created the world, as the Lord's-day to commemorate the reſurrection of Chriſt. And as for the Jews ſenſe of the fourth commandment, ſome of the learneſt of their criticks are pleaſed to diſtinguiſh betwixt the words *zachôr* and *ſmôr*, *remember*, and *keep*, imployed in the command of ſolemnizing the ſabbath; for, the remembering of it they hold to be an act of religion, performable by all mankind, that are capable of it, and acquainted with its having been commanded; though the keeping of it holy they ſuppoſe only enjoined to the Iſraelites. On which occaſion I remember I was one ſabbath-day entertained at his own lodgings, by a learned Jew (who taught me the holy language) with meat then newly dreſſed; to remove my wonder at which, he told me, 'That it was dreſſed by 'Chriſtians, who, being Gentiles, were not 'obliged to the ſtrict and legal obſervation 'of the ſabbath.' But whatever be thought of this Jewiſh notion, yet queſtionleſs, if the fourth commandment do not, at leaſt, divers other paſſages of ſcriptures do much diſcountenance their ſeverity, who would fright men from the indagation of nature. And he, that ſhall duly conſider divers texts obvious enough in the book of *Job*, and the *Pſalms* (beſides other parts of the bible) will not readily conclude, that natural philoſophy and divinity are at ſuch variance, as the divines we deal with would perſuade us. St. *Paul* Rom. i. 20. ſeems to inform us, that the inviſible things, of God, from the creation of the world, are clearly ſeen, being underſtood by the things, that are made, even *his eternal power and Godhead:* ſo that they, that were mentioned before, are without excuſe. And though I ignore not, that not only ſeveral of the Socinians following their maſter *Socinus*, but ſome few orthodox writers, are pleaſed to give a very differing interpretation of that text, and make the ἀόρατα ἀυτῦ ἀπο κτίσεως κόσμυ, to ſignify thoſe things of God, that have been inviſible ever ſince the creation of the world, and referring the ποιήματα *to things not made*, as we tranſlate it, *but done* (as the miracles of Chriſt and his Apoſtles) yet I ſee no neceſſity, why the ποιήματα ſhould be taken in a ſenſe excluſive of the creation, and not at leaſt admitted to take in all the ways and methods imployed by God, to manifeſt the *inviſible things* there intimated unto man. And certainly, however St. *Paul* may be ſuppoſed to appear but darkly, yet *Job* was clearly of a differing opinion from theirs, who teach, *That the ſtudy of nature leads to atheiſm:* Job xii. 7, *for aſk now the beaſts* (ſays he) *and they will* 8. 9. *teach thee; and the fowls of the air, and they ſhall tell thee; or ſpeak to the earth, and it ſhall teach thee; and the fiſhes of the ſea ſhall declare unto thee. Who knoweth not in all theſe, that the hand of the Lord hath wrought this?* And conſonantly hereunto (which it were not amiſs for our adverſaries to take notice of) we may obſerve; That almoſt all the writers of natural theology, and the moſt alſo of thoſe, that have laboured to demonſtrate the truth of Chriſtian religion (divers of whom have been as well profound divines, as otherwiſe eminent ſcholars) have undertaken to evince, by the conſideration of the univerſe, both that there is a God, and that he is the author of it. Which I the rather mention, *Pyrophilus*, becauſe I would not be miſtaken, as if I diſputed againſt divines in general, or were guilty of the leaſt irreverence towards a faculty, in whoſe ſtudy I have thought my ſelf obliged, as a Chriſtian, to ſpend much of my time; and eſpecially, I would not appear diſreſpectful to divines in *England*, where they have already been but too much vilified, though queſtionleſs for their ſins againſt God, yet, I fear, not without the ſin of their oppreſſors.

That Phyſiologers cannot explicate by ſecond cauſes all the phænomena of nature, ſo as to exclude the firſt.

In the next place I conſider, that ſince phyſiology is ſaid to tempt to atheiſm, but by enabling men to give an account of the phænomena of nature, by the knowledge of ſecond cauſes, without taking in the firſt, it will not be ſo eaſy a matter, as many preſume, for the contemplation of nature, to turn a conſidering man atheiſt. For we are yet, for aught I can find, far enough from being able to explicate all the phænomena of nature by any principles whatſoever. And even of the atomical philoſophers, whoſe ſect ſeems to have the moſt ingeniouſly attempted it, ſome of the eminenteſt have themſelves freely acknowledged to me, their being unable to do it convincingly to others, or ſo much as ſatisfactorily to themſelves. And indeed, not only the generation of animals is a myſtery, which all, that naturaliſts have ſaid to explain it, have been far enough from depriving of that name; but we ſee, that to explicate all the various phænomena, that belong to that ſingle inanimate, and ſeemingly homogeneous body, mercury, ſo as not to make any hypotheſis aſſumed, to make out one of its properties or effects, incongruous to any other hypotheſis requiſite to the explanation of any of the reſt, hath been hitherto found ſo difficult, that if our poſterity be not much happier unriddlers, than our fore-fathers or we have been, it is like to prove a taſk capable of defeating the induſtry and attempts, I ſay not of more than one philoſopher, but of more than one age; even our chymical tortures hitherto having, from that deluding *Proteus*, forced no confeſſions, that bring us not more wonder than ſatisfaction, and do not beget almoſt as many ſcruples, as they reſolve.

* See of the Abyſſine or Æthiopian Chriſtians, and likewiſe of the Maronites in the Eaſt, in reference to their celebration of the Saturday, *Alex. Roſſe*, in his *View of all Religions*, and the Authors by him cited.

ESSAY

ESSAY IV.

Containing a requiſite Digreſſion concerning thoſe, that would exclude the Deity from intermeddling with Matter.

That ſome of the Peripatetick ſect are guilty of this endeavour.

I IGNORE not, that not only *Leucippus*, *Epicurus*, and other Atomiſts of old, but of late ſome perſons, for the moſt part adorers of *Ariſtotle*'s writings, have pretended to be able to explicate the firſt *beginning of things* and the world's phænomena, without taking in, or acknowledging any divine author of it. And therefore, though we may elſewhere, by the aſſiſtance of that author, have an opportunity to give you an account of our unſatisfiedneſs with the attempts made by ſome bold wits in favour of ſuch pretenſions; yet ſince the main truth we plead for in this diſcourſe, is ſo nearly concerned in what hath been taught by thoſe, that would keep God from being thought to have any ſhare in the production of the univerſe, I can ſcarce forbear (as unwilling as I am to digreſs) to repreſent to you, on the preſent occaſion, a few conſiderations, which may aſſiſt you, if not to leſſen the arrogance of ſuch perſons, at leaſt, to keep your ſelf from thinking their evidence as great, as their confidence is wont to be. Now of the philoſophers we ſpeak of, ſome being Atomiſts, and others not, it will be requiſite to ſay ſomething to each of the two ſorts: and becauſe we not long ſince, in an illuſtrious company, where you, *Pyrophilus*, are not unknown, met with one of them, who avowedly grounded his opinions on the Ariſtotelian or vulgar phyſiology, we ſhall firſt recommend to you two or three conſiderations concerning ſuch arrogant Peripateticks, (for I ſpeak not of that ſect in general, of which I know there are divers excellent men.)

That their hypotheſis is very full of miſtakes.

FIRST then, you will in many paſſages of the following eſſays, find, that divers things, that have been very magiſterially taught, and confidently believed among the followers of *Ariſtotle*, are errors or miſtakes; and that as ſeveral, even of the obvious phænomena of nature, do contradict the common Peripatetick doctrine, ſo divers, at leaſt of thoſe, that are more abſtruſe, are not explicable by it: and as confidently as theſe his followers talk of the expounding the very riddles of nature; yet I remember, that he himſelf ſomewhere (for I cannot call to mind the place) did not ſcruple to confeſs, that *As the eyes of owls are to the ſplendor of the day, ſo are thoſe of our minds even to things obvious and manifeſt.*

That theſe excluders of the Deity make but imperfect explications of the phænomena of nature.

I SHALL next take notice, that philoſophers, who ſcorn to aſcribe any thing to God, do often deceive themſelves, in thinking they have ſufficiently ſatisfied our inquiries, when they have given us the neareſt and moſt immediate cauſes of ſome things; whereas oftentimes the aſſignment of thoſe cauſes is but the manifeſting, that ſuch and ſuch effects may be deduced from the more catholick affections of things, though theſe be not unfrequently as abſtruſe, as the phænomena explicated by them, as having only their effects more obvious, not their nature better underſtood: as when, for inſtance, an account is demanded of that ſtrange ſuppoſed ſympathy betwixt quickſilver and gold; in that we find, that whereas all other bodies ſwim upon quickſilver, it will readily ſwallow up gold, and hide it in its boſom. This pretended ſympathy the naturaliſt may explicate, by ſaying, that gold being the only body heavier than quickſilver of the ſame bulk, the known laws of the Hydroſtaticks make it neceſſary, that gold ſhould ſink in it, and all lighter bodies ſwim on it. But though the cauſe of this effect be thus plauſibly aſſigned, by deducing it from ſo known and obvious an affection of bodies, as gravity, which every man is apt to think he ſufficiently underſtands; yet will not this put a ſatisfactory period to a ſevere inquirer's curioſity, who will, perchance, be apt to alledge, that though the effects of gravity indeed be very obvious, yet the cauſe and nature of it are as obſcure, as thoſe of almoſt any phænomenon it can be brought to explicate. And that therefore he, that deſires no further account, deſiſts too ſoon from his inquiries, and acquieſces long before he comes to his journey's end *. And indeed, the inveſtigation of the true nature and adequate cauſe of gravity, is a taſk of that difficulty, that in ſpite of aught I have hitherto ſeen or read, I muſt yet retain great doubts, whether they have been clearly and ſolidly made out by any man. And ſure, *Pyrophilus*, there are divers effects in nature, of which though the immediate cauſe may be plauſibly aſſigned, yet if we further inquire into the cauſes of thoſe cauſes, and deſiſt not from aſcending in the ſcale of cauſes, till we are arrived at the top of it, we ſhall perhaps find the more catholick and primary cauſes of things to be either certain, primitive, general, and fixt laws of nature (or rules of action and paſſion among the parcels of the univerſal matter,) or elſe the ſhape, ſize, motion, and other primary affections of the ſmalleſt parts of matter, and of their firſt coalitions or cluſters †; eſpecially thoſe endowed with ſeminal faculties or properties, or (to diſpatch) the admirable conſpiring of the ſeveral parts of the univerſe to the production of particular effects; of all which

And do not explain the ſcale of cauſes unto the laſt cauſe.

* Phyſiologo qui veritatem contemplatur ultimarum cauſarum cognitio non finis eſt, ſed initium ad primas ſupremaſque cauſas proficiſcendi. *Plutarch. l.* de primo Frigido.

† Τὸ πρῶτον αἴτιον ἐν τῇ ἐυρήσει ἔχατον. Ariſtot. Ethic. Nicom. Lib. III. cap. 8.

which it will be difficult to give a ſatisfactory account, without acknowledging an intelligent author or diſpoſer of things.

AND the better to clear ſo weighty a truth, let us further conſider on this occaſion, that not only *Ariſtotle*, and thoſe that, miſ-led by his authority, maintain the eternity of the world, but very many other philoſophers and phyſicians, who aſcribe ſo much to nature, that they will not be reduced to acknowledge an author of it, are wont very much to delude both themſelves and others in the account they preſumie to give us, as ſatisfactory, of the cauſes or reaſons of very many effects. I will not inſtance in the magnetick properties of things, nor any of thoſe numerous abſtruſities of nature, which it is well-known that the Ariſtotelians are wont to refer to ſympathy, antipathy, or occult qualities, and ſtrive to put men off with empty names, whereby they do not ſo much leſſen our ignorance, as betray their own.

Inſtances of things, wherein their account is not ſatisfactory; as 1. *In the particulars, the cauſes of which, they aſſign occult qualities.*

BUT I ſhall inſtance in thoſe more obvious phænomena, of which they ſuppoſe they have given us very ſatisfactory accounts. If you aſk one of thoſe I ſpeak of, whence it comes to paſs, that if a man put one end of a long reed into a veſſel full of water, and ſuck at the other end, his mouth will be immediately filled with that liquor; he will readily tell you, that the ſuction drawing the air out of the cavity of the reed, the water muſt neceſſarily ſucceed in the place deſerted by the air, to prevent a vacuity abhorred by nature. If you likewiſe aſk ſuch a man, why too women, about a certain age, their *purgationes menſtruæ* do commonly ſupervene; he will think he has ſufficiently anſwered you, when he has told you, that about that age, beginning to be ripe for procreation, nature has wiſely provided, that their ſuperfluous blood ſhould be ſent to the uterine veſſels, partly to diſburden the maſs of blood of an uſeleſs load, and partly to contribute matter, or at leaſt afford nouriſhment in caſe of conception. But though theſe ſolutions are wont to be acquieſced in by ſuch as thoſe that give them, yet I ſee not how they can ſatisfy a rigid reaſoner. For not now to mention, what may be objected againſt them out of ſome modern mechanical and anatomical obſervations, let us a little conſider, that to ſay, that the aſcent of the water in the firſt problem proceeds from nature's deteſtation of a vacuity, ſuppoſes that there is a kind of *anima mundi*, furniſhed with various paſſions, which watchfully provides for the ſafety of the univerſe; or that a brute and inanimate creature, as water, not only has a power to move its heavy body upwards, contrary (to ſpeak in their language) to the tendency of its particular nature, but knows both that air has been ſucked out of the reed, and that unleſs it ſucceed the attracted air, there will follow a vacuum; and that this water is withall ſo generous, as by aſcending, to act contrary to its particular inclination for the general good of the univerſe, like a noble patriot, that ſacrifices his private intereſts to the publick ones of his country.

2. When they aſſign nature's abhorrency of vacuity to be the cauſe, that water doth aſcend in ſuction.

BUT to ſhew men by an eaſy experiment, how little attraction is performed to avoid a vacuum, I have ſometimes done thus. I have taken a ſlender pipe of glaſs, of about four foot long, and putting one of the open ends of it into a veſſel full of quickſilver, I have ſucked as ſtrongly as I could at the other, and cauſed one to watch the aſcent of the quickſilver, and mark where it was at the higheſt, and I found not, that at one ſuck I could raiſe it up much above a foot; and having cauſed a couple of ſtrong men, one after another, to ſuck at the ſame end of the ſame pipe, I found not, that either of them could draw it up much higher. Nor did it appear, that by repeated ſuctions, though the upper end of the pipe were each time ſtopt, to hinder the relapſe of the quickſilver, it could at all be raiſed above the ſeven and twenty digits, at which it uſed to ſubſiſt in the Torricellian experiment *de vacuo*. Whereas the ſame end of the tube being put into a ſmall veſſel of water, I could at one ſuck make the water ſwiftly aſcend through the perpendicularly held tube into my mouth; which argues, that the aſcenſion of liquors upon ſuction rather depends upon the preſſure of the air (againſt the liquors and the ſucker's cheſt) and their reſpective meaſures of gravity and lightneſs compared to that preſſure, than it proceeds from ſuch an abhorrency of a vacuum as is preſumed.

Whereas the contrary is proved in the ſuction of the quickſilver.

AND ſo likewiſe in the other queſtion propoſed, it is implied, that there is in a female body ſomething, that knows the rule of phyſicians, that of a plethora, the cure is the convenient evacuation of blood; and that this intelligent faculty is wiſe enough alſo to propoſe to it ſelf the double end above mentioned, in this evacuation, and therefore will not provide a quantity blood great enough to require an excretion, nor begin it till the female be come to an age, wherein it is poſſible for both the ends to be obtained: and that alſo this preſiding nature is ſo charitable, as, that mankind might not fail, it will make the female ſubject to ſuch monthly ſuperfluities of blood, from which experience informs us, that a whole ſet of diſeaſes, peculiar to that ſex, does frequently proceed. And in a word, there is a multitude of problems, eſpecially ſuch as belong to the uſe of the parts of human body, and to the cauſes and cures of the diſeaſes incident thereunto, in whoſe explication thoſe, we write of, content themſelves to tell us, that nature does ſuch and ſuch a thing, becauſe it was fit for her ſo to do; but they endeavour not to make intelligible to us what they mean by this nature, and how meer, and conſequently brute, bodies can act according to laws, and for determinate ends, without any knowledge either of the one or of the other. Let them therefore, till they have made out their hypotheſis more intelligibly, either ceaſe to aſcribe to irrational creatures ſuch actions, as in men are apparently the productions of reaſon and choice, and ſometimes even of induſtry and virtue; or elſe let them with us acknowledge, that ſuch actions of creatures in themſelves irrational are performed under the ſuperintendence and guidance

3. When they aſſign the cauſes of the purgationes menſtruæ.

And when in other caſes they aſcribe to irrational creatures ſuch actions, as in men are the productions of reaſon and choice.

of a wise and intelligent author of things. But that you may not mistake me, *Pyrophilus*, it will be requisite for me, to acquaint you, in two or three words, with some of my present thoughts concerning this subject: that there are some actions so peculiar to man, upon the account of his intellect and will, that they cannot be satisfactorily explicated after the manner of the actings of meer corporeal agents, I am very much inclined to believe. And whether or no there may be some actions of some other animals, which cannot well be mechanically explicated, I have not here leisure or opportunity to examine. But for (most of) the other phænomena of nature, methinks we may, without absurdity, conceive, that God, of whom in the scripture it is affirmed, *That all his works are known to him from the beginning*, having resolved, before the creation, to make such a world as this of ours, did divide (at least if he did not create it incoherent) that matter, which he had provided, into an innumerable multitude of very variously figured corpuscles, and both connected those particles into such textures or particular bodies, and placed them in such situations, and put them into such motions, that by the assistance of his ordinary preserving concourse, the phænomena, which he intended should appear in the universe, must as orderly follow, and be exhibited by the bodies necessarily acting according to those impressions or laws, though they understand them not at all, as if each of those creatures had a design of self-preservation, and were furnished with knowledge and industry to prosecute it; and as if there were diffused through the universe an intelligent being, watchful over the publick good of it, and careful to administer all things wisely for the good of the particular parts of it, but so far forth as is consistent with the good of the whole, and the preservation of the primitive and catholick laws established by the supreme cause: as in the formerly mentioned clock of *Strasburg*, the several pieces making up that curious engine are so framed and adapted, and are put into such a motion, that though the numerous wheels, and other parts of it, move several ways, and that without any thing either of knowledge or design; yet each performs its part in order to the various ends, for which it was contrived, as regularly and uniformly, as if it knew and were concerned to do its duty. And the various motions of the wheels and other parts concur to exhibit the phænomena designed by the artificer in the engine, as exactly as if they were animated by a common principle, which makes them knowingly conspire to do so, and might, to a rude Indian, seem to be more intelligent than *Conradus Dasypodius* himself, that published a description of it; wherein he tells the world, that he contrived it, who could not tell the hours, and measure time so accurately as his clock. And according to this notion, if you be pleased to bear it in your memory, *Pyrophilus*, you may easily apprehend in what sense I use many common phrases, which custom hath so authorized, that we can scarce write of physiological subjects, without employing either of them, or frequent and tedious circumlocutions in their stead. Thus when I say, that a stone endeavours to descend towards the center of the earth, or that being put into a vessel of water, it affects the lowest place; I mean, that not such a mathematical point as the center of the earth hath power to attract all heavy bodies, the least of which, it being a point, it cannot harbour; or that a stone does really aim at that unknown and unattainable center: but that, as we say, that a man strives or endeavours to go to any place, at which he would quickly arrive, if he were not forcibly hindered by some body, that holds him fast where he is, and will not let him go; so a stone may be said to strive to descend, when either by the magnetical steams of the earth, or the pressure of some subtile matter incumbent on it, or by what ever else may be the cause of gravity, the stone is so determined to tend downwards, that if all impediments, interposed by the neighbouring bodies, were removed, it would certainly and directly fall to the ground; or being put into a vessel with water, or any other liquor much less heavy than it self (for on quicksilver, which is heavier, stones will swim) the same gravity will make it subside to the bottom of the vessel, and consequently thrust away its bulk of water, which though heavy in it self, yet because it is less ponderous than the stone, seems to be light. And so in our late instance in the clock, if it be said, that the hand, that points at the hours, effects a circular motion, because it constantly moves round the center of the dial-plate, it is evident, that the inanimate piece of metal affects not that motion more than any other, but only, that the impression it receives from the wheels, and the adaptation of the rest of the engine, determine it to move after that manner. And though if a man should with his finger stop that index from proceeding in its course, it may be said, in some sense, that it strives or endeavours to prosecute its former circular motion; yet that will signify no more, than that by virtue of that contrivance of the engine, the index is so impelled, that if the obstacle, put by the finger of him that stops it, were taken away, the index would move onwards, from that part of the circle where it was stopt, towards the mark of the next hour. Nor do I by this, *Pyrophilus*, deny, that it may in a right sense be said, as it is wont to be in the schools, that *Opus naturæ est opus intelligentiæ*: neither do I reject such common expressions as *nature always affects and intends that which is best*, and *nature doth nothing in vain*. For since I must, according to the above mentioned notion, refer many of the actions of irrational creatures to a most wise Disposer of things, it can scarce seem strange to me, that in those particulars, in which the author intended, as it was requisite, that irrational creatures should operate so and so for their own preservation, or the propagation of their species, or the publick good of the universe, their actions being ordered by a reason transcending ours, should not only oftentimes resemble the actings of reason in us, but sometimes even surpass them.

Acts xv. 18.

The author's conceit concerning God's creation of the parts of the world, and so placing them, that they (by the assistance of his ordinary concourse) must needs exhibit these phænomena

Illustrated by the motions of the clock at Strasburg.

How far such borrowed and metaphorical phrases, which custom has authorised, may be used.

Quicksilver being heavier than stones, they swim thereon, yet sink in lighter liquors.

That the instances of the action of divers creatures, resembling reason, commend the wisdom of God

them. As in effect we ſee ſilk-worms and ſpiders can, without being taught, ſpin much more curiouſly their balls and webs, than our beſt ſpinſters could; and that ſeveral birds can build and faſten their neſts more artificially, than many a man, or perhaps any man could frame and faſten ſuch little and elaborate buildings. And the induſtries of foxes, bees, and divers other beaſts, are ſuch, that it is not much to be wondered at, that thoſe creatures ſhould have reaſon aſcribed to them by divers learned men; who yet perhaps would be leſs confident, if they conſidered how much may be ſaid for the immortality of all rational ſouls, and that the ſubtile actings of theſe beaſts are determined to ſome few particulars requiſite for their own preſervation, or that of their ſpecies; whereas, on all other occaſions, they ſeem to betray their want of reaſon, and by their voice and geſtures ſeem to expreſs nothing, but the natural paſſions, and not any rational or logical conceptions. And therefore, as when (to reſume our former compariſon) I ſee in a curious clock, how orderly every wheel and other parts perform its own motions, and with what ſeeming unanimity they conſpire to ſhew the hour, and accompliſh the other deſigns of the artificer; I do not imagine, that any of the wheels, *&c.* or the engine it ſelf is endowed with reaſon, but commend that of the workman, who framed it ſo artificially. So when I contemplate the actions of thoſe ſeveral creatures, that make up the world, I do not conclude the inanimate pieces, at leaſt, that it is made up of, or the vaſt engine it ſelf, to act with reaſon or deſign, but admire and praiſe the moſt wiſe Author, who by his admirable contrivance can ſo regularly produce effects, to which ſo great a number of ſucceſſive and conſpiring cauſes are required.

AND thus much, *Pyrophilus*, having been repreſented concerning thoſe, that rejecting from the production and preſervation of things all but nature, yet embrace the principles of the vulgar philoſophy, you will perhaps think it more than enough; but object, that what is not to be expected from the barren principles of the ſchools, may yet be performed by thoſe atomical ones, which we our ſelves have, within not very many pages, ſeemed to acknowledge ingenious. And I know indeed, that the modern admirers of *Epicurus* confidently enough pretend, that he and his expoſitors have already, without being beholden to a Deity, clearly made out, at leaſt the origin of the world, and of the principal bodies it is made up of. But I confeſs, I am ſo far from being convinced of this, that I have been confirmed rather, than unſettled in my opinion of the difficulty of making out the original of the world, and of the creatures, eſpecially the living ones, that compoſe it, by conſidering the accounts which are given us of the nativity (if I may ſo ſpeak) of the univerſe, and of animals, by thoſe great denyers of creation and providence, *Epicurus*, and his paraphraſt *Lucretius:* whoſe having ſhown themſelves (as I freely confeſs they have) very ſubtile philoſophers in explicating divers myſteries of nature, ought not ſo much to recommend to us their impious errors about the original of things, as to let us ſee the neceſſity of aſcribing it to an intelligent cauſe. This then is the account of this matter, which is given us by *Epicurus* himſelf, in that epiſtle of his to *Herodotus*, which we find in *Diogenes Laertius: Quod ad meteora attinet, exiſtimari non oportet, aut motum, aut converſionem, aut eclipſin, aut ortum occaſumvè, aut alia hujuſcemodi ideo fieri, quod ſit præfectus aliquis, qui ſic diſponat, diſpoſueritvè, ac ſimul beatitudinem immortalitatemque poſſideat:* 'As to the meteors, 'you ought not to believe, that there is either 'motion, or change, or eclipſe, or the riſe or 'ſetting of them, becauſe of any ſuperior pre-'ſident, which doth, or hath ſo diſpoſed of it, 'and himſelf poſſeſſes all the while happineſs 'and immortal life.' And having interpoſed ſome lines, to prove, that the providence of God is not conſiſtent with his felicity, he adds, *Quare opinandum eſt, tum cum mundus procreatus eſt, factos fuiſſe eos circumplexus convolventium ſe atomorum, ut nata fuerit hæc neceſſitas, quâ circuitus tales obierint:* 'Wherefore you 'muſt think, that when the world was made, 'thoſe implications and foldings of atoms hap-'pened, which cauſed this neceſſity, that theſe 'bodies ſhould paſs through theſe motions.' And elſewhere in the ſame epiſtle; *Infiniti* (ſays he) *ſunt mundi, alii ſimiles iſti, alii vero diſſimiles. Quippe atomi cum ſint infinitæ, ut non multo ante demonſtratum eſt per infinitatem ſpatiorum, & alibi aliæ, ac procul ab hoc ad fabrefactionem mundorum infinitorum variè concurrunt.* 'There are infinite worlds, ſome like this, 'ſome unlike it: for ſince atoms are infinite (as 'I newly ſhewed from the infiniteneſs of the 'ſpaces) ſome in one, other in others, diſtant 'parts of theſe ſpaces far from us, variouſly 'concur to the making of infinite worlds.' And leſt this Epicurean explication of the world's original ſhould ſeem to owe all its unſatisfactorineſs to its obſcure brevity, we ſhall not ſcruple to give you that elegant paraphraſe and expoſition of it, which *Lucretius* has delivered in his 5th book, *De Rerum Naturâ:*

Sed quibus ille modis, conjectus materiaï
Fundarit cælum, ac terram pontique profunda
Solis, lunaï curſus ex ordine ponam,
Nam certe neque conſiliis primordia rerum
Ordine ſe quæque atque ſagaci mente locarunt,
Nec quos quæque darent motus pepigere profectò:
Sed quia multa modis multis primordia rerum
Ex infinito jam tempore percita plagis,
Ponderibuſque ſuis, conſuerunt concita ferri,
Omnimodiſque coïre, atque omnia pertentare,
Quæcunque inter ſe poſſent congreſſa creare;
Propterea fit, ut magnum volgata per ævum,
Omnigenos cœtus & motus experiundo,
Tandem conveniant: ea quæ conjuncta repentè
Magnarum rerum fiant exordia ſæpè
Terraï maris, & cœli generiſque animantum.

'But how at firſt, when matter thus was 'whirl'd,
'Heaven, earth, and ſea, the high and 'lower world,

Defects in the explication of nature by the Epicureans, who deny the concurrence of God.

The

'The ſun and moon, and all were made,
'I'll ſhew.
'For ſure the firſt rude atoms never knew
'By ſage intelligence, and counſel grave,
'T' appoint the places, that all beings have:
'Nor will I think, that all the motions here
'Order'd at firſt by fixt agreements were,
'But th' elements, that long had beat about,
'Been buffetted, now in, now carried out:
'Screwed into every hole, and tried to take
'With any thing, in any place to make
'Somewhat at laſt; after much time and coil,
'Motions and meetings, and a world of toil
'Made up this junto. And thus being
'join'd,
'And thus in kind embraces firmly twin'd,
'And link'd together, they alone did frame,
'Heaven, earth, and ſea, and the creatures
'in the ſame.'

THE hypotheſis expreſſed in theſe verſes (which pleaſe our author ſo well, that he has almoſt the ſame lines in ſeveral other places of his poem) he proſecutes and applies to ſome particular parts of the univerſe in the ſame 5th book: but whilſt he thus refuſeth to allow God an intereſt in the world's production, his hypotheſis requires, that we ſhould allow him ſeveral things, which he doth aſſume, not prove: as firſt, that matter is eternal. 2. That from eternity it was actually divided, and that into ſuch inſenſibly ſmall parts, as may deſerve the name of atoms; whereas it may be ſuppoſed, that matter, though eternal, was at firſt one coherent maſs, it belonging to matter to be diviſible, but not ſo of neceſſity, to be actually divided. 3. That the number of theſe atoms is really infinite. 4. That theſe atoms have an *inane infinitum* (as the Epicureans ſpeak) to move in. 5. That theſe atoms are endowed with an almoſt infinite variety of determinate figures, ſome being round, others cubical, others hooked, others conical, *&c*, whereas not to mention beforehand what we may elſewhere object beſides againſt this aſſumption, he ſhews not why, nor how this atom came to be ſpherical rather than conical, and another hooked rather than pyramidal: but theſe aſſumptions I inſiſt not on, becauſe of two others much more conſiderable, which our author is fain to take for granted in his hypotheſis. For 6thly, he ſuppoſes his eternal atoms to have from eternity been their own movers, whereas it is plain, that motion is no way neceſſary to the eſſence of matter, which ſeems to conſiſt principally in extenſion: for matter is no leſs matter when it reſts, than when it is in motion; and we daily ſee many parcels of matter paſs from the ſtate of motion to that of reſt, and from this to that, communicating their motion to matter, that lay ſtill before, and thereby looſing it themſelves. Nor has any man, that I know, ſatisfactorily made out how matter can move itſelf: and indeed, in the bodies, which we here below converſe withal, we ſcarce find, that any thing is moved but by ſomething elſe; and even in theſe motions of animals, that ſeem ſpontaneous, the will or appetite doth not produce the motion of the animal, but guide and determine that of the ſpirits, which by the nerves move the muſcles; and ſo the whole body, as may appear by the wearineſs and unwieldineſs of animals, when by much motion the ſpirits are ſpent. And accordingly I find that *Anaxagoras*, though he believed, as *Ariſtotle* did after him, that matter was eternal, yet he diſcerned, that the notion of matter not neceſſarily including motion, there was a neceſſity of taking in a *mens*, as he ſtyles God, to ſet this ſluggiſh matter a moving. And I remember *Ariſtotle* himſelf, in one place of his Metaphyſicks, diſputing againſt ſome of the ancienter philoſophers, aſks, *Quonamque modo movebuntur, ſi nulla erit actu cauſa? non enim ipſa materia ſeipſam movebit, ἀλλὰ τεκτονικὴ rerum opifex virtus:* 'How ſhall 'things be moved, if there be no actual cauſe? 'For matter cannot move itſelf, but requires 'to be moved by a tectonick thing, creating 'power.' But though elſewhere I have met with paſſages of his near of kin to this, yet he ſeems not to expreſs his opinion uniformly and clearly enough to engage me to define it, or make a weapon of it: and therefore I ſhall rather proceed to take notice, that, according to the Epicurean hypotheſis, not only the motion, but the determination of that motion is ſuppoſed. For *Epicurus* will have his atoms move downwards, and that not in parallel lines, leſt they ſhould never meet to conſtitute the world, but according to lines ſomewhat inclining towards one another; ſo that there muſt be not only motion, but gravity in atoms, before there be any center of gravity for them to move towards; and they muſt move rather downwards than upwards, or ſideways, and in ſuch lines as nothing is produced capable of confining them to. Which are aſſumptions ſo bold and precarious, that I find ſome, even of his admirers, to be aſhamed of them: which will ſave me the labour of arguing againſt them, and allow me to take notice in the ſeventh place, that this Epicurean doctrine ſuppoſes, that a ſufficient number of atoms, and their motion downwards, being granted, there will need nothing but their fortuitous concourſe in their fall, to give a being to all thoſe bodies, that make up the world. Indeed, that the various coalitions of atoms, or at leaſt ſmall particles of matter, might have conſtituted the world, had not been perhaps a very abſurd opinion for a philoſopher, if he had, as reaſon requires, ſuppoſed, that the great maſs of lazy matter was created by God at the beginning, and by him put into a ſwift and various motion, whereby it was actually divided into ſmall parts of ſeveral ſizes and figures, whoſe motion and croſſings of each other were ſo guided by God, as to conſtitute, by their occurſions and coalitions, the great inanimate parts of the univerſe, and the ſeminal principles of animated concretions. And therefore I wonder not much, that the Mileſian *Thales* (the firſt of the Grecian philoſophers, as *Cicero* informs us,) that inquired into theſe matters) ſhould hold that opinion, which *Tully* expreſſes in theſe words: *Aquam dixit eſſe initium rerum, Deum autem eam mentem, quæ ex aqua cuncta finxerat:* 'He 'ſaid,

Ariſtot. Metaphyſ. lib. 12. c. 6.

De Nat. Deorum. lib. 1.

'ſaid, water was the principle of all things, 'but God was that intelligence, that made all 'things out of water:' And that of *Anaxagoras* the ſame author ſhould give us this account; *Idem ibidem.* *Omnium rerum deſcriptionem & modum mentis infinitæ vi ac ratione deſignari & confici voluit:* 'The delineation and manner of all things he 'thought to be deſigned and made by the 'power and reaſon of infinite intelligence.' For though theſe great men exceedingly erred, in thinking it neceſſary, that God ſhould be provided of a pre-exiſtent, and by him not created matter, to make the world of; yet at leaſt they diſcerned and acknowledged the neceſſity of a wiſe and powerful agent, to diſpoſe and faſhion this rude matter, and contrive it into ſo goodly a ſtructure, as we behold, without imagining with *Epicurus*, that chance ſhould turn a chaos into a world. And really it is much more unlikely, that ſo many admirable creatures, that conſtitute this one exquiſite and ſtupendous fabrick of the world, ſhould be made by the caſual confluence of falling atoms, juſtling or knocking one another in the immenſe vacuity, than that in a printer's working-houſe a multitude of ſmall letters, being thrown upon the ground, ſhould fall diſpoſed into ſuch an order, as clearly to exhibit the hiſtory of the creation of the world, deſcribed in the 3 or 4 firſt chapters of *Geneſis*; of which hiſtory, it may be doubted, whether chance may ever be able to diſpoſe the fallen letters into the words of one line. I ignore not, that ſometimes odd figures, and almoſt pictures, may be met with, and may ſeem caſually produced in ſtones, and divers other inanimate bodies; and I am ſo far from denying this, that I may elſewhere have opportunity to ſhew you, that I have been no careleſs obſerver of ſuch varieties.

That the figures in nitre, cryſtal, and divers minerals are produced, not by chance, but by ſomewhat analogous to ſeminal principles.

BUT firſt, even in divers minerals, as we may ſee in nitre, cryſtal, and ſeveral others, the figures, that are admired, are not unqueſtionably produced by chance, but perhaps by ſomething analogous to ſeminal principles, as may appear by their uniform regularity in the ſame ſort of concretion, and by the practice of ſome of the ſkilfulleſt of the ſalt-petre men, who, when they have drawn as much nitre as they can out of the nitrous earth, caſt not the earth away, but preſerve it in heaps for ſix or ſeven years; at the end of which time, they find it impregnated with new ſalt-petre, produced chiefly by the ſeminal principle of nitre implanted in that earth. To prove, that metalline bodies were not all made at the beginning of the world, but have ſome of them a power, though ſlowly, to propagate their nature, when they meet with a diſpoſed matter; you may find many notable teſtimonies and relations in a little book of *Phyſico-chymical Queſtions*, written by *Jo. Conradus Gerhardus*, a German doctor, and moſt of them recited (together with ſome of his own) by the learned *Sennertus*. But leſt you ſhould ſuſpect the narratives of theſe authors, as ſomewhat partial to their fellow-chymiſts opinions, I ſhall here annex that memorable relation, which I find recorded by *Linſchotten*, and *Garcias ab Horto*, a pair of unſuſpected writers in this caſe, concerning diamonds; whereby it may appear, that the ſeminal principles of thoſe precious ſtones, as of plants, are lodged in the bowels of the mine they grow in. *Diamonds* (ſays the firſt, in that chapter of his travels, where he treats of thoſe jewels) *are digged like gold out of mines; where they digged one year the length of a man into the ground, within three or four years after, there are found diamonds again in the ſame place, which grow there; ſometimes they find diamonds of* 400 *or* 800 *grains. Adamantes* (ſays the latter) *qui altiſſimè in terræ viſceribus, multiſque annis perfici debebant in ſummo ferè ſolo generantur, & duorum aut trium annorum ſpatio perficiuntur: nam ſi in ipſa fodina hoc anno ad cubiti altitudinem fodias, adamantes reperies. Poſt biennium rurſus illic excavato ibidem, invenies adamantes.* 'Diamonds, which ought 'to be brought to perfection in the deepeſt 'bowels of the earth, and in a long tract of 'time, are almoſt at the top of the ground, 'and in three or four years ſpace made per-'fect. For if you dig this year but the depth 'of a cubit, you will find diamonds; and af-'ter two years dig there, you will find dia-'monds again.' And next, how inconſiderable, alas! are theſe ſuppoſed productions of chance, in compariſon of the elaborate contrivances of nature in animals? ſince in the body of man, for inſtance, of ſo many hundred parts it is made up of, there is ſcarce any, that can be either left out, or made otherwiſe than as it is, or placed elſewhere than where it is, without an apparent detriment to that curious engine; ſome of whoſe parts, as the eye, and the valves of the veins, would be ſo unfit for any thing elſe, and are ſo fitted for the uſes, that are made of them, that it is ſo far from being likely, that ſuch ſkilful contrivances ſhould be made by any being not intelligent, that they require a more than ordinary intelligence to comprehend how ſkilfully they are made.

Sempl. in India nascenti. lib. 1. cap. 47.

That the generation of animals is much leſs to be accounted the production of chance.

As for the account that *Lucretius*, out of *Epicurus*, gives us of the firſt production of men, in I know not what wombs adhering to the ground, and which much more becomes him as a poet, than as a philoſopher; I ſhall not here waſte time to manifeſt its unlikelineſs, that witty father *Lactantius**, having done already that copiouſly for me. And indeed it ſeems ſo pure a fiction, that, were it not, that the hypotheſis he took upon him to maintain, could ſcarce afford him any leſs extravagant account of the original of animals, the unſuitableneſs of this Romance to thoſe excellent notions, with which he has enriched divers other parts of his works, would make me apt to ſuſpect, that when he writ this part of his poem, he was in one of the fits of that frenzy, which ſome, even of his admirers, ſuppoſe him to have been put into by a philtre, given him by his, either wife or miſtreſs *Lucilia*; in the

* Tanta ergo qui videat, & talia poteſt exiſtimare nullo affecta eſſe conſilio, nulla providentia, nulla ratione divina, ſed ex atomis ſubtilibus exiguis concreta eſſe tanta miracula? Nonne prodigio ſimile eſt, aut natum eſſe hominem, qui hæc diceret, ut Leucippum aut extitiſſe qui crederet, ut Democritum, qui auditor ejus fuit, vel Epicurum in quem vanitas omnis de Leucippi fonte profluxit. Lib. II. cap 11.

intervals of which, they ſay, that he writ his books.

That the hypotheſes of philoſophy only ſhew, that an effect may be produced by ſuch a cauſe, not that it muſt.

AND here let us further conſider, that as confidently as many atomiſts, and other naturaliſts, preſume to know the true and genuine cauſes of the things they attempt to explicate; yet very often the utmoſt they can attain to, in their explications, is, that the explicated phænomena may be produced after ſuch a manner, as they deliver, but not that they really are ſo. For as an artificer can ſet all the wheels of a clock a going, as well with ſprings as with weights; and may with violence diſcharge a bullet out of the barrel of a gun, not only by means of gunpowder, but of compreſſed air, and even of a ſpring: ſo the ſame effects may be produced by divers cauſes different from one another; and it will oftentimes be very difficult, if not impoſſible, for our dim reaſons to diſcern ſurely, which of theſe ſeveral ways, whereby it is poſſible for nature to produce the ſame phænomena, ſhe has really made uſe of to exhibit them. And ſure, he, that in a ſkilful watch-maker's ſhop ſhall obſerve, how many ſeveral ways watches and clocks may be contrived, and yet all of them ſhew the ſame things; and ſhall conſider how apt an ordinary man, that had never ſeen the inſide but of one ſort of watches, would be to think, that all theſe are contrived after the ſame manner, as that, whoſe fabrick he has already taken notice of; ſuch a perſon, I ſay, will ſcarce be backward to think, that ſo admirable an engineer as nature, by many pieces of her workmanſhip, appears to be, can, by very various and differing contrivances, perform the ſame things; and that it is a very eaſy miſtake for men to conclude, that becauſe an effect may be produced by ſuch determinate cauſes, it muſt be ſo, or actually is ſo. And as confident as thoſe we ſpeak of uſe to be, of knowing the true and adequate cauſes of things, yet *Epicurus* himſelf, as appears by ancient teſtimony, and by his own writings, was more modeſt, not only contenting himſelf, on many occaſions, to propoſe ſeveral poſſible ways, whereby a phænomenon may be accounted for, but ſometimes ſeeming to diſlike the ſo pitching upon any one explication, as to exclude and reject all others: and ſome modern philoſophers, that much favour his doctrine, do likewiſe imitate his example, in pretending to aſſign not preciſely the true, but poſſible cauſes of the phænomenon they endeavour to explain.

That to a perfect knowledge there muſt not only appear the poſſible, but the definite and real; not only the general, but the particular cauſes.

And I remember, that *Ariſtotle* himſelf (whatever confidence he ſometimes ſeems to expreſs) does in his firſt book of *Meteors* ingenuouſly confeſs, that concerning many of nature's phænomena, he thinks it ſufficient, that they may be ſo performed as he explicates them. But granting, that we did never ſo certainly know, in the general, that theſe phænomena of nature muſt proceed from the magnitudes, figures, motions, and thence reſulting qualities of atoms, yet we may be very much to ſeek as to the particular cauſes of this or that particular effect or event. For it is one thing to be able to ſhew it poſſible, for ſuch and ſuch effects to proceed from the various magnitudes, ſhapes, motions, and concretions of atoms; and another thing to be able to declare what preciſe, and determinate figures, ſizes, and motions of atoms, will ſuffice to make out the propoſed phænomena, without incongruity to any others to be met with in nature: as it is one thing for a man ignorant of the mechanicks to make it plauſible, that the motions of the famed clock at *Straſburg*, are performed by the means of certain wheels, ſprings, and weights, *&c.* and another to be able to deſcribe diſtinctly the magnitude, figures, proportions, motions, and, in ſhort, the whole contrivance either of that admirable engine, or ſome other capable to perform the ſame things.

NAY, a lover of diſputing would proceed farther, and queſtion that way of reaſoning, which even the eminenteſt atomiſts are wont to imploy to demonſtrate, that they explicate things aright.

Some defects in the ways of reaſoning uſed by the moſt eminent atomiſts.

FOR the grand argument, by which they uſe to confirm the truth of their explications, is, that either the phænomenon muſt be explicated after the manner by them ſpecified, or elſe it cannot at all be explicated intelligibly: in what ſenſe we diſallow not, but rather approve this kind of ratiocination, we may elſewhere tell you. But that, which is in this place more fit to be repreſented, is, that this way of arguing ſeems not in our preſent caſe ſo cogent, as they, that are wont to employ it, think it to be: for beſides, that it is bold to affirm, and hard to prove, that what they cannot yet explicate by their principles, cannot poſſibly be explicated by any other men, or any other philoſophy; beſides this, I ſay, that which, they would reduce their adverſaries to, as an abſurdity, ſeems not to deſerve that name. For ſuppoſing the argument to be concluſive, that either the propoſed explication muſt be allowed, or men can give none at all, that is intelligible; I ſee not what abſurdity it were to admit of the conſequence. For who has demonſtrated to us, that men muſt be able to explicate all nature's phænomena, eſpecially ſince divers of them are ſo abſtruſe, that even the learnedeſt atomiſts ſcruple not to acknowledge their being unable to give an account of them. And how will it be proved, that the omniſcient God, or that admirable contriver, Nature, can exhibit phænomena by no ways, but ſuch as are explicable by the dim reaſon of man? I ſay explicable, rather than intelligible; becauſe there may be things, which though we might underſtand well enough, if God, or ſome more intelligent being than our own, did make it his work to inform us of them, yet we ſhould never of our ſelves find out thoſe truths. As an ordinary watch-maker may be able to underſtand the curiouſeſt contrivance of the ſkilfulleſt artificer, if this man take care to explain his engine to him, but would never have underſtood it, if he had not been taught: whereas to explicate the nature and cauſes of the phænomena we are ſpeaking of, we muſt not only be able to underſtand, but to inveſtigate them.

AND whereas, it is peremptorily inſiſted on by ſome Epicureans, who thereby pretend to demonſtrate the excellency and certainty of their

their explications, that, according to them, nature is declared to produce things, in the way that is moſt facile and agreeable to our reaſon: it may be replied, that what we are to inquire after, is, how things have been, or are really produced; not whether or no the manner of their production be ſuch, as may the moſt eaſily be underſtood by us: for if all things were, as thoſe we reaſon withall maintain, caſually produced, there is no reaſon to imagine, that chance conſidered what manner of their production would be the moſt eaſily intelligible to us. And if God be allowed to be, as indeed he is, the author of the univerſe, how will it appear that he, whoſe knowledge infinitely tranſcends ours, and who may be ſuppoſed to operate according to the dictates of his own immenſe wiſdom, ſhould, in his creating of things, have reſpect to the meaſure and eaſe of human underſtandings; and not rather, if of any, of angelical intellects? So that whether it be to God or to chance, that we aſcribe the production of things, that way may often be fitteſt or likelieſt for nature to work by, which is not eaſieſt for us to underſtand.

AND as for the way of arguing, ſo often imployed (eſpecially againſt the truth we now contend for) and ſo much relied on by many modern philoſophers, namely, that they cannot clearly conceive ſuch or ſuch a thing propoſed, and therefore think it fit to be rejected; I ſhall readily agree with them, in the not being forward to aſſent to any thing, eſpecially in philoſophy, that cannot well be conceived by knowing and conſidering men. But there is ſo much difference among men, as to their faculty of framing diſtinct notions of things, and through men's partiality or lazineſs, many a particular perſon is ſo much more apt, than theſe men ſeem to be aware of, to think, or at leaſt to pretend, that he cannot conceive, what he has no mind to aſſent to, that a man had need be wary, how he rejects opinions, that are impugned only by this way of ratiocination: by which, I hope, it will not be expected, that we ſhould be more prevailed with, than that ſect of philoſophers that imploys it moſt. And among thoſe, that reſolve the phænomena of nature into the mechanical powers of things, or the various figures, ſizes and motions of the parts of matter, I meet with ſome, as the Epicureans, who tell us, they cannot frame a notion of an incorporeal ſubſtance or ſpirit, nor conceive how, if the ſoul were ſuch, it could act upon the body: and yet others, that ſeem no leſs ſpeculative, ſeriouſly and ſolemnly profeſs, that they can conceive a clear and diſtinct notion of a ſpirit, which they believe the human ſoul, that regulates at leaſt, if not produces divers motions of the body, to be; denying on the other ſide, that it can be clearly conceived, either that any thing, that is only material, can think, or that there can poſſibly be any vacuum (that is, place without any body) in the univerſe: both which the Epicureans profeſs themſelves not only to conceive as poſſible, but believe as true.

AND thus much, *Pyrophilus*, it may ſuffice to have ſaid in relation to thoſe, who would reject God from having any thing to do, either in the production or government of the world, upon this ground, that they, if you will believe them, can explicate the original and phænomena of it without him; but it is not all, nor the greateſt part of the favourers of the atomical philoſophy, that preſume ſo much of themſelves, and derogate ſo much from God. To ſay therefore ſomething to the more moderate and judicious of that perſuaſion, we will candidly propoſe on their behalf the moſt plauſible objection we can foreſee, againſt the truth we have been all this while pleading for. They may then thus argue againſt us, that though the atomiſts cannot ſufficiently demonſtrate from what natural cauſes every particular effect proceeds, and ſatisfactorily explicate after what determinate manner each particular phænomenon is produced; yet it may ſuffice to take away the neceſſity of having recourſe to a Deity, that they can make out in general, that all the things, that appear in the world, may, and muſt be performed by meerly corporeal agents; or, if you pleaſe, that all nature's phænomena may be produced by the parcels of the great maſs of univerſal matter, variouſly ſhaped, connected, and moved. As a man, that ſees a ſcrewed gun ſhot off, though he may not be able to deſcribe the number, bigneſs, ſhape, and co-aptation of all the pieces of the lock, ſtock, and barrel, yet he may readily conceive, that the effects of the gun, how wonderful ſoever they may ſeem, may be performed by certain pieces of ſteel, of iron, and ſome parcels of wood, of gunpowder, and of lead, all faſhioned and put together according to the exigency of the engine; and will not doubt, but that they are produced by the power of ſome ſuch mechanical contrivance of things purely corporeal, without the aſſiſtance of ſpiritual or ſupernatural agents.

The moſt plauſible argument of the oppoſers of a Deity conſidered.

IN anſwer to this objection, I muſt firſt profeſs to you, that I make great doubt, whether there be not ſome phænomena in nature, which the atomiſts cannot ſatisfactorily explain by any figuration, motion, or connection of material particles whatſoever: for ſome faculties and operations of the reaſonable ſoul in man are of ſo peculiar and tranſcendent a kind, that as I have not yet found them ſolidly explicated by corporeal principles, ſo I expect not to ſee them in haſte made out by ſuch. And if a ſpiritual ſubſtance be admitted to enter the compoſition of a man, and to act by and upon his body; beſides that one of the chief and fundamental doctrines of the Epicureans (namely, that there is nothing in the univerſe but *corpus* and *inane*) will thereby be ſubverted, it will appear, that an incorporeal and intelligent being may work upon matter, which would argue, at leaſt a poſſibility, that there may be a ſpiritual Deity, and that he may intermeddle with, and have an influence upon the operations of things corporeal. But to inſiſt no longer on this, let us give a further and direct anſwer to the propoſed objection, by repreſenting, that although as things are now eſtabliſhed in the world, an atomiſt were ableto explain the phænomena we meet with,

by ſuppoſing the parts of matter to be of ſuch ſizes, and ſuch ſhapes, and to be moved after ſuch a manner, as is agreeable to the nature of the particular phænomenon to be thereby exhibited; yet it would not thence neceſſarily follow, that, at the firſt production of the world, there was no need of a moſt powerful and intelligent being, to diſpoſe that chaos or confuſed heap of numberleſs atoms into the world, to eſtabliſh the univerſal and conſpiring harmony of things; and eſpecially to connect thoſe atoms into ſuch various ſeminal contextures, upon which moſt of the more abſtruſe operations, and elaborate productions of nature appear to depend. For many things may be performed by matter variouſly figured and moved, which yet would never be performed by it, if it had been ſtill left to it ſelf without being, at firſt at leaſt, faſhioned after ſuch a manner, and put into ſuch a motion by an intelligent agent. As the quill, that a philoſopher writes with, being dipt in ink, and then moved after ſuch and ſuch a manner upon white paper, all which are corporeal things, or their motions, may very well trace an excellent and rational diſcourſe; but the quill would never have been moved after the requiſite manner upon the paper, had not its motion been guided and regulated by the underſtanding of the writer. Or rather, yet once more, to reſume our former example of the *Straſburg*-clock; though a ſkilful artiſt, admitted to examine and conſider it, both without and within, may very well diſcern, that ſuch wheels, ſprings, weights, and other pieces, of which the engine conſiſts, being ſet together in ſuch a coaptation, are ſufficient to produce ſuch and ſuch motions, and ſuch other effects as that clock is celebrated for; yet the more he diſcerns the aptneſs and ſufficiency of the parts to produce the effects emergent from them, the leſs he will be apt to ſuſpect, that ſo curious an engine was produced by any caſual concurrence of the parts it conſiſts of, and not rather by the ſkill of an intelligent and ingenious contriver; or that the wheels, and other parts, were of this or that ſize, or this or that determinate ſhape, for any other reaſon, than becauſe it pleaſed the artificer to make them ſo: though the reaſon, that moved the artificer to employ ſuch figures and quantities ſooner than others, may well be ſuppoſed to have been, that the nature of his deſign made him think it very proper and commodious for its accompliſhment, if not better than any other ſuited to the ſeveral exigencies of it.

If an Epicurean ſhould be told, that a man, after having been for ſome days really dead, became alive again, I think it will not be doubted, but that he would reject ſuch a relation as impoſſible, and therefore too manifeſtly falſe to be believed by any man in his wits: and yet, according to his principles, the man, as well ſoul as body, conſiſted only of divers particles of the univerſal matter, by various motions brought together, and diſpoſed after a certain manner: and conſequently, he muſt ground his perſuaſion, that it is impoſſible to redintegrate the engine once ſpoiled by death, upon this, that as chance cannot with the leaſt probability be preſumed to have produced ſuch a ſtrange effect; ſo, according to him, there can be no cauſe aſſigned, knowing and powerful enough to rally and bring together again the diſbanded and ſcattered parcels of matter (or ſubſtitute other equivalent ones) that, together with the remaining carcaſs, compoſed the dead man, ſo to re-unite them to the reſt; and laſtly, ſo to place and put into motion both the one and the other, as were requiſite to make a living man once more reſult from them. I know, that this example reaches not all the circumſtances of the controverſy we have been debating; but yet, if I miſtake not, it will ſerve the turn, for which I propoſe it. For, not now to inſiſt upon this inference from it, That a conſidering man may confidently reject a thing, that is not abſolutely impoſſible, provided it be highly incredible; not to inſiſt on this, I ſay, the thing I aim at in the mention of it, is only to ſhew, that ſuch things may poſſibly be effected by matter and motion, as no wiſe man will believe to have been produced by a bare agitation of the particles of matter, not guided by the ſuperintendency of a powerful and knowing Director.

Now that the atoms, or particles of matter, of which the world conſiſts, made no agreement with each other to convene and ſettle in the manner requiſite to conſtitute the univerſe, *Lucretius* does not ſo properly confeſs, as affirm, in that fore-cited paſſage, where he judiciouſly tells us, that

> *—Certè neque conſiliis primordia rerum*
> *Ordine ſe quæque, atque ſagaci mente locarunt:*
> *Nec quos quæque darent motus pepigêre profectò.*

And the thing it ſelf is manifeſt enough, from the nature of atoms confeſſedly inanimate and devoid of underſtanding.

So that although we ſhould grant, *Pyrophilus*, the poſſible emergency of the innumerable effects we admire in the world, from the various properties and coalitions of atoms, yet ſtill you ſee the formerly mentioned difficulty (touching the reſulting of all things from matter left to it ſelf) would recur; and it would as well be incredible, that an innumerable multitude of inſenſible particles, as that a leſſer number of bigger parcels of matter, ſhould either conſpire to conſtitute, or fortuitouſly juſtle themſelves into ſo admirable and harmonious a fabrick as the univerſe, or as the body of man; and conſequently it is not credible, that they ſhould conſtitute either, unleſs as their motions were (at leaſt, in order to their ſeminal contextures and primary coalitions) regulated and guided by an intelligent contriver and orderer of things. And I ſhould ſo little think it a diſparagement to have but ſo much ſaid of any hypotheſis of mine, that I ſuppoſe I may affirm it, without offending either the moſt ſober, or the generality of the atomical philoſophers, to whom, and to their doctrine, my writings will manifeſt to be no otherwiſe affected than I ought.

ESSAY V.

Wherein the Diſcourſe, interrupted by the late Digreſſion, is reſumed and concluded.

IT remains now, *Pyrophilus*, that we at length return into the way from whence the foregoing digreſſion has, I fear, too long diverted us; and that to proſecute and finiſh our diſcourſe, we take it up where we left it, and were tempted to digreſs; namely, at the third eſſay; betwixt which, and the beginning of this fifth, all that has been interpoſed may be looked upon but as a long parentheſis.

That there are ſome things in nature, which conduce much to the evincing of a Deity, which are only well known to naturaliſts.

IN the third place then I conſider, that whether or no it be true, which our antagoniſts ſuggeſt, that there are ſome things in nature, which tempt philoſophers more than they do the vulgar, to doubt or deny a God; yet certainly there are divers things in nature, that do much conduce to the evincing of a Deity, which naturaliſts either alone diſcern, or at leaſt diſcern them better than other men. For beſides the abſtruſe properties of particular bodies, not diſcovered by any but thoſe, that make particular inquiries into thoſe bodies, there are many things in nature, which to a ſuperficial obſerver ſeem to have no relation to one another; whereas to a knowing naturaliſt, that is able to diſcern their ſecret correſpondencies and alliances, theſe things, which ſeem to be altogether irrelative each to other, appear ſo proportionate and ſo harmonious both betwixt themſelves, and in reference to the univerſe they are parts of, that they repreſent to him a very differing and incomparably better proſpect than to another man: as he, that looks upon a picture made up of ſcattered and deformed pieces, beholding them united into one face by a cylindrical looking-glaſs aptly placed, diſcerns the ſkill of the artiſt, that drew it, better than he, that looks only on the ſingle parts of that picture, or upon the whole picture, without the uniting cylinder. Which brings into my mind, that whereas in the ſacred ſtory of the creation, when mention is made of God's having conſidered the works of each of the firſt ſix days, at the end of it, it is ſaid of the work of every day, *That God ſaw, that it was good*, (except of the ſecond day, becauſe the ſeparation of the waters was but imperfectly made on that day, and compleated in the next, on which it is therefore twice ſaid, *That God ſaw, that it was good*;) whereas, I ſay, when God looked upon his works in particular, it is only ſaid, *That he ſaw, that they were good:* when he is introduced at the cloſe of the creation, as looking upon, and ſurveying his creatures in their harmony, and entire ſyſtem, it is emphatically ſaid, *That he ſaw every thing, that he had made, and behold it was very good.* And if *Ariſtotle* be indeed the author of the book *De Mundo ad Alexandrum*, which paſſes for his, and is ſaid to have been written by him towards the end of his life, it would not be unworthy our obſervation to take notice, how he, that in his other writings is wont to talk of God's intereſt in the creatures darkly, and heſitantly enough, is wrought upon by the contemplation of the univerſe, as it is an orderly aggregate or ſyſtem of the works of nature, to make expreſſions of the divine architect, which are not unworthy of *Ariſtotle*, though, being meerly human, they cannot be worthy of God. Amongſt many, I ſhall ſingle out ſome; and I hope, *Pyrophilus*, you will excuſe me, if in this eſſay, and ſome of the precedent ones, I do, contrary to my cuſtom, employ pretty ſtore of paſſages taken out of other authors. For firſt, the nature of my deſign makes it requiſite for me to ſhew, what opinion the heathen philoſophers had of the ſtudy of phyſiology, and what power their contemplation of nature had to ingage them to acts of religion. And next, ſince divers of the ſame paſſages, wherein they had ſet down their opinions, contained alſo the grounds and reaſons of them, whereby they have anticipated much of what we ſhould ſay upon the ſame ſubjects; I was unwilling to deprive you of their pertinent ratiocinations, or rob them of the glory of what they had well written. And this neceſſary apology premiſed, let us proceed to conſider his paſſages; and firſt, *Reſtat* (ſays he) *ut ſummatim de cauſa diſſeramus, quæ cunctarum ipſa rerum vim habet tutricem & continentem, quemadmodum cætera perſtrinximus: flagitii enim inſtar eſſet, cum de mundo dicere inſtituerim, tractatu ſi minus exquiſito fortaſſe, at certè qui ſat eſſe poſſit ad formulam doctrinæ craſſiorem, intactam præcipuam mundi partem principemque præterire.* 'It remains, that we 'ſpeak briefly concerning that cauſe, whoſe 'power preſerves and ſupports all things, 'in like manner, as we have compendiouſly 'handled other matters. For it would ſeem 'criminal to paſs over the chief part of the 'world untouched, having deſigned to diſ-'courſe of the univerſe in a treatiſe, which, if 'leſs accurate, yet certainly may be ſufficient 'for a rough platform of doctrine.' And a little after, *Etenim* (ſays he) *cunctarum quæ rerum natura complectitur, cum ſervator eſt Deus, tum vero quæcunque in hoc mundo quoquomodo perficiuntur, eorum omnium idem eſt genitor: non ſic tamen ipſe ut opificis in morem, animaliſque laſſitudinem ſentientis labore affici poſſit, ut qui ea facultate utatur, quæ nulli cedat difficultati, cujus ipſe vi facultatis omnia in poteſtate continet, nec minus etiam quæ longius ab ipſo videntur eſſe ſummota:* 'For God is both the preſerver of 'all things contained in the univerſe, and like-'wiſe the producer of every thing whatſoever, 'which is in any wiſe made in this world: yet 'not ſo as to be ſenſible of labour; after the man-'ner of a workman, or a creature, which is ſub-'ject to wearineſs: for he is endued with a power, 'which is inferiour to no difficulty, and where-'by

Explained by the compariſon of the uniting ſcattered pieces of paint into one face by a cylindrical looking-glaſs.

Ariſt. de Mundo, cap. 6.

Ibidem.

The teſtimony of the author of the book de Mundo, *aſcribed to* Ariſtotle, *introduced.*

'by he contains all things under his authority, 'even such as seem most distant from him.' *Eodem Cap.* To which purpose he elsewhere says, *Augustius decentiusque existimandum est, Deum summo in loco ita esse collocatum; numinis ut tamen ejus vis per universum mundum pertingens, tum solem, lunamque moveat, tum cœlum omne circumagat, simulque causam præbeat eorum, quæ in terra sunt salutis atque incolumitatis:* 'It is more 'magnificent and agreeable to conceive God so 'resident in the highest place, that nevertheless his divine energy being diffused throughout the whole world, moves both the sun 'and moon, turns round the whole globe of 'heaven, and affords the causes of safety and 'preservation of such things as are upon the *Eodem Cap.* 'earth.' And in the same book he adds, *Ut vero summatim loquamur, quod in navi gubernator est, quod in curru agitator, quod in choro præcentor, quod denique lex in civitate, & dux in exercitu, hoc Deus est in mundo. Nisi si hactenus interest quod labor, & motus multiplex illos exercet & curæ angunt variæ, cum huic illaborata succedunt omnia, omnis molestiæ expertia:* 'But to sum up all in brief; what the pilot is in 'a ship, what the driver in a chariot, what 'the chief singer is in a dance; finally, what 'magistracy is in a commonwealth, and the 'general in an army, that is God in the world: 'unless there be this difference, that much 'toil and manifold cares perplex them, but all 'things are performed by God without labour 'or trouble.' And certainly he, that is a stranger to anatomy, shall never be able to discern in the circulation of the blood, the motion of the chyle, and the contrivance of all the parts of a human body, those proofs, as well as effects, of an omniscient Δημιουργος, or artist, which a curious anatomist will discover in that elaborate and matchless engine: as I remember, I had occasion not long since to take notice of in the shape of that strange muscle (the *obturator internus*) which some call from its figure *marsupialis*, serving to the motion of the thigh. For this muscle seems so made, as if nature had designed in it to manifest, that she is skilled in the mechanicks, not only as a mathematician, that understands the powers of distance, weight, proportion, motion and figure; but as an artificer, or handycrafts man, who knows by dextrous contrivances to furnish the more endangered parts of his work, with what is more useful to make it lasting; there being (to omit other observables, belonging to that muscle) a deep notch made in the coxendix, to shorten the way betwixt the two extremities of the muscle, and make it bear upon the bone with a blunter angle. And because the tendon is long, lest, notwithstanding the former provision, it should be apt to fret out upon the edge of the bone, nature has provided for it a musculous piece of flesh, wherein it is as it were sheathed, that so it might not immediately bear, and grate upon the bone; just as our artificers use to sew cases of leather upon those parts of silken strings, which being to grate upon harder bodies, were otherwise endangered to be fretted out by attrition.

Of the admirable contrivance of the make of the musculus marsupialis.

AND a like skilfulness of nature in the mechanical contrivance of the parts, is more obviously discernible in the structure of that admirable engine, by which such variety of other engines are made, the hand: where (not to mention the *ligamentum latum*, or wrist-band, that keeps the tendons, that move under it, from inconveniently starting up upon the contraction of the respective muscles) the wonderful perforations, that are made through the tendons of the *musculi perforati* by those of the *musculi perforantes*, for the more commodious motion of the joints of the fingers, may conspicuously manifest the mechanical dexterity of nature; as it may her husbanding (if I may so speak) of her work, that in a fœtus, whilst it lies in the womb, because the lungs are not to be displayed as afterwards, and so the blood needs not circulate thorough them, from the right ventricle of the heart into the left, for the use of respiration, as it must in grown animals, she contrives a nearer way; and by certain short pipes, peculiar to such young creatures, she more commodiously performs in them the circulation of the blood, proportioned to their present condition; and afterwards, when the animal is brought out of the womb into the open air, and put upon the constant exercise of his lungs, these temporary conduit-pipes, little by little, vanish. So careful is nature not to do things in vain.

And of the parts of the hand.

The contrivance for the circulation of the blood in a fœtus before the use of respiration.

AND therefore I do not much wonder, that *Galen*, though I remember he somewhere (unprovokedly and causelessly enough) derides *Moses*, and seems not over-much inclined to make religious acknowledgements; yet when he comes to consider particularly the exquisite structure of a human body, should break forth into very elevated, and even pathetical celebrations of God, and tell us, that in his books, *De Usu Partium*, he composed hymns to the Creator's praise. And certainly he, that shall see a skilful anatomist dextrously dissect that admirable part of man, the eye, and shall consider the curious contrivance of the several coats, humors, and other parts it consists of, with all their adaptions and uses, would be easily persuaded, that a good anatomist has much stronger invitations to believe, and admire an omniscient Author of nature, than he, that never saw a dissection; especially if he should see how all of these concur to make up one optical instrument, to convey the species of the visible object to the optick nerve, and so to the brain; as I have with pleasure considered it, in the recent eye of a cat (for with keeping it will grow flaccid) cut cleanly off, where the optick nerve enters the sclerotis, and is going to expand itself into the retina; for holding this eye at a convenient distance betwixt yours and a candle, you may see the image of a flame lively expressed upon that part of the back side of the eye, at which the optick nerve enters the above mentioned sclerotis. Something of this kind we have also shown our friends with eyes of dead men, carefully sever'd from their heads; and with the (dexterously taken out) crystalline humour of a human eye, we have often read, as with a lens or magnifying glass. And

Galen's speech, that his books de Usu Partium *were as hymns to the Creator.*

Galenus lib. 3o. De Usu Partium.

The fabrick of the eye considered.

Some experimental observations of the eye, and use of its parts in order to vision.

to

to aſſiſt you in ſo pleaſing a ſpeculation, as that of the eye, we ſhall add, that by reaſon ox eyes are much larger, and more eaſier to be had than human ones, we are wont to make much uſe of them, and to diſcern ſome things better in their coats, we immerſe them for a little while in boiling water; and to be able to conſider the form and bigneſs of the vitreous and cryſtalline humours, better than the fluidity of the one, and the ſoftneſs of the other are wont to allow anatomiſts to do; we have ſometimes, by a way hereafter to be ſet down, ſpeedily frozen eyes, and thereby have turned the vitreous humour into very numerous and diaphanous films (as it were of ice, and the cryſtalline into a firm ſubſtance,) but (which perhaps you will wonder at) not tranſparent. An eye thus frozen may be cut along that, which optical writers call the optical axis, and then it affords an inſtructive proſpect, which we have not been able to obtain any other way. But becauſe, notwithſtanding this expedient in the eyes of men, and the generality of terreſtrial animals, the opacouſneſs of the ſclerotis hinders the pictures, that outward objects (unleſs they be lucid ones) make within the eye to be clearly diſcerned; we think our ſelves obliged to that excellent mathematician of your acquaintance, *Pyrophilus*, who, upon ſome diſcourſe we had with him concerning this ſubject, lately adviſed us to make uſe of the eyes of white rabbits (for if thoſe animals be of another colour, he ſays, their eyes will not prove ſo fit for our purpoſe.) For having held ſome of theſe eyes at a convenient diſtance betwixt my eyes and the window, I found them to be ſo tranſparent, that the rays proceeding from the pains of glaſs, Iron bars, *&c.* of the window, paſſing though the cryſtalline humor and in their paſſage refracted, did, on the retina, exhibit in an inverted poſture, according to the optical laws, the contracted, but lively pictures of thoſe external objects; and thoſe pictures, by reaſon of the tranſparency of the ſclerotis, became viſible through it to my attentive eyes: as in a darkened room the ſhadows of objects without it, projected on a fine ſheet of paper, may, by reaſon of the thinneſs of paper, be ſeen thorough it by thoſe that ſtand behind it. By candle-light we could ſee little in the bottom of theſe eyes but lucid objects, ſuch as the flame of the candle, which appeared tremulous, though inverted; but by day-light we could manifeſtly diſcern in them, both the motions of very neighbouring objects, and the more vivid of their colours.

The way to prepare the eyes of animals for the better making obſervations on them

Some particulars wherein the eyes of white rabbits are better than others for obſervation.

AND really, *Pyrophilus*, it ſeems to me, not only highly diſhonourable for a reaſonable ſoul to live in ſo divinely built a manſion, as the body ſhe reſides in, altogether unacquainted with the exquiſite ſtructure of it; but I am confident, it is a great obſtacle to our rendering God the praiſes due to him, for his having ſo excellently lodged us, that we are ſo ignorant of the curious workmanſhip of the manſions our ſouls live in: for not only the Pſalmiſt, from the conſideration of the divine art diſplayed by God, in the moulding and faſhioning his body in the womb, takes a juſt occaſion to celebrate his Maker, *I will praiſe thee* (ſays he) *becauſe I am fearfully and wonderfully made. Marvellous are thy works, and that my ſoul knoweth right well: my ſubſtance was not hid from thee, when I was made in ſecret, and curiouſly wrought*, (with as much curioſity as tapeſtry or embroidery, as the Hebrew *Rukkamti* ſeems to import.) *In the loweſt parts of the earth thine eyes did ſee my ſubſtance, yet being unperfect; and in thy book all my members were written, which in continuance were faſhioned, when as yet there were none of them.* But even from *Galen* himſelf anatomical reflections have been able to extort expreſſions of devotion: *Cum igitur* (ſays he) *quod in omnibus recte fit, omnes ad artem referunt, quod autem in uno, aut duobus non ad artem, ſed fortunam; merito ex noſtri ſtructura corporis licet admirari ſummam artem, æquitatem & vim naturæ quæ nos conſtruxit. Conſtat ſiquidem corpus noſtrum ex oſſibus pluribus quam ducentis, ad ſingula oſſa vero pervenit nutriens vena; ſicut ad muſculos: cum hâc etiam arteria & nervi; pariaque adamuſſim ſunt, & omnino ſimilia in dextra animantis ſita, iis quæ in altera ſunt; os oſſi, muſculus muſculo, vena venæ, arteria arteriæ, ac nervus nervo; idque exceptis viſceribus, atque nonnullis particulis, quæ habere propriam deſcriptionem videntur. Duplices itaque corporis noſtri partes, omnino inter ſe ſunt ſimiles & magnitudine & conformatione, ſicuti & conſiſtentia quam voco juxta mollitiem, duritiemque differentia. Quemadmodum igitur de humanis effectibus judicium faciamus, ex navi ſumma arte conſtructa cognoſcentes peritiam artificis, ita etiam de Divinis facere convenit, corporiſque noſtri opificem admirari, quicunque tandem is deorum exiſtat, etiamſi eum non videmus:* 'Whereas therefore (ſaith he) all men aſcribe 'that to art, which is made aright in all reſpects, but that, which is only in one or 'two, not to art, but fortune; the ſtructure 'of our body gives us cauſe to admire the excellent art, exactneſs, and power of nature, 'which framed us. For our body conſiſts of 'above two hundred bones; to each of which 'tends a vein for conveying of nouriſhment '(in like manner as to the muſcles) which is 'accompanied with an artery and a nerve; and 'the parts are exactly pairs, and thoſe placed 'in the right ſide of an animal are wholly 'alike to thoſe in the other, bone to bone, 'muſcle to muſcle, vein to vein, artery to artery, and nerve to nerve; excepting only 'the bowels, and ſome other parts, which 'ſeem to have a peculiar conſtruction. So 'that the parts of our body are double, and 'altogether alike among themſelves, both in 'greatneſs and ſhape, as alſo in conſiſtence, 'which I place in the diverſity of ſoftneſs and 'hardneſs. As therefore we uſe to judge of 'things made by men, acknowledging the 'ſkill of a workman, by the building of a 'ſhip with extraordinary art; ſo alſo it behoveth to do in thoſe of God, and to admire the framer of our body, whoſoever of 'the gods he were, although we do not ſee 'him.'

Pſal. cxxxix 14, 15, 16.

Proved out of inſtances in the Pſalmiſt and Galen.

Galen de plac. Hip. & Plat. lib. 7.

That it is diſhonourable for the ſoul to be unacquainted with the exquiſite ſtructure of the body, being its own manſion.

PERHAPS it may be truly ſaid yet further, that

that, although in human bodies, many wonders, as we have lately mentioned, have been diſcovered to us by anatomy, yet anatomy it ſelf has not diſcovered to us all the wonders to be met with in a human body, nor will detect them, till anatomiſts be ſkilled in ſome other things over and above that of dexterouſly diſſecting. For it ſeems very probable, that the excellent contrivance of ſome parts will never be fully apprehended, without a competent knowledge of the nature of thoſe juices, that are to paſs thorough them, and ſome of them receive their beginning, or ſome alteration, in them; and the nature of theſe juices will ſcarce be exactly known, without ſome ſkill in divers parts of phyſiology, and eſpecially in chymiſtry. Beſides, the reaſon of the origination, ſhape, bulk, length, progreſs, and inſertion of each particular muſcle, can hardly be well accounted for without ſome ſkill in the principles of mechanicks, and in the nature and properties of leavers, pulleys, *&c.* Moreover, there is a certain harmonious proportion betwixt the parts of a human body, in reference both to the whole, and to one another, which is not wont to be heeded by anatomiſts, but much taken notice of by ſtatuaries and painters. For they reckon, that when a man's arms are diſplayed, the diſtance betwixt his middle fingers is equal to the height of his body; ſo they reckon ſometimes ſeven, ſometimes eight lengths of the head, to the length of the body; and four times the length of the noſe to that of the head, as three times the ſame length to that of the face. And divers ſuch obſervations we have met with among them, which we ſhall not now inſiſt on, but rather tell you, that without ſome ſkill in opticks, it will be hard for an anatomiſt to ſhew the wiſdom of God in making the cryſtalline humour of the eyes of men only of a ſomewhat convex or lenticular form, rather than as thoſe of fiſhes of an almoſt perfectly ſpherical one, (as to the anterior part, which is obverted to the outward objects.) Nor do I remember, that in anatomy ſchools I have heard any account give of this difference, which yet tends much to manifeſt the wiſdom of the author of nature, who has ſo excellently ſuited the eyes of animals to the ſeveral parts of the univerſe he deſigned them to inhabit. For men, and other terreſtrial animals living in the air, the beams of light, reflected from viſible objects, and falling over the cornea, and the aqueous humour, do neceſſarily ſuffer a refraction there, as coming from the air, which is a thinner medium, into a thicker, and ſo there needs the leſs of farther refraction to be made by the cryſtalline humour, and conſequently its figure needs to be but moderately convex: whereas fiſhes living conſtantly in the water, the medium, through which they ſee things, is almoſt of a like thickneſs with the cornea and aqueous humour; ſo that there being little or no refraction made in their eyes but by the cryſtalline it ſelf, it was neceſſary, that that ſhould be exceedingly convex, that it might make a very great refraction, and thereby unite the beams nearer at hand; which, if the cryſtalline were leſs convex, would tend to a point of concourſe beyond the retina, and conſequently paint on it but a languid and confuſed picture of the object they ſhould repreſent.

Why the anterior part of fiſhes eyes ought to be more ſpherical than thoſe of men.

As for *Paracelſus*, certainly he is injurious to man, if (as ſome eminent chymiſts expound him) he calls man a microcoſm, becauſe his body is really made up of all the ſeveral kinds of creatures the macrocoſm or greater world conſiſts of, and ſo is but a model or epitome of the univerſe: for (to omit, that the ancients, as *Galen* informs us, gave the title of microcoſms to animals in general) it is the glory and prerogative of man, that God was pleaſed to make him, not after the world's image, but his own. On which occaſion give me leave to tell you, that however the conſideration of the dignity conferred on us in the image of God, (in whatever that image be reſolved to conſiſt) ſhould, methinks, be ſome engagement to us to look upon our ſelves as belonging unto God; as our Saviour, from the image of *Cæſar* ſtampt upon a coin, pronounced it fit to render unto *Cæſar* the things of *Cæſar*, and to God thoſe of God.

That God made man not after the world's image, but his own.

Lib. 3. De Uſu Part.

That the image of God on us ſhould engage us to eſteem ourſelves as belonging to God.

In the fourth place, I conſider, that the univerſal experience of all ages manifeſts, that the contemplation of the world has been much more prevalent to make thoſe, that have addicted themſelves to it, believers, than deniers of a Deity. For it is very apparent, that the old philoſophers, for the moſt part, acknowledged a God; and as evident it is, by their want of revelation, by many paſſages in their writings, and by divers other things not now to be inſiſted on, that the conſideration of the works of nature was the chief thing, that induced them to acknowledge a divine author of them. This truth I could eaſily make out, were I at leiſure to tranſcribe teſtimonies, which, becauſe I am not, I ſhall content my ſelf to mention to you one, which may well ſerve for many, it being a confeſſion made by *Ariſtotle*, or whatever other learned philoſopher it was, who writ the book *de Mundo*, that God's being the architect and upholder of the world was the general belief of the ages, that preceded his. *Vetus* (ſays he) *ſermo eſt à majoribus proditus, inter omnes homines, univerſa tum ex Deo tum per Deum conſtituta fuiſſe atque coagmentata, nullamque naturam ſatis inſtructam ad ſalutem eſſe poſſe, quæ citra Dei præſidium, ſuæ ipſa demum tutelæ permiſſa ſit:* 'It is an ancient tradition (ſaith 'he) diffuſed amongſt all mankind from our 'anceſtors, that all things were made and pro-'duced of God, and by God; and that no 'nature can be ſufficiently furniſhed for its own 'ſafety, which is left without the ſupport of 'God, to its own protection.' And as for both the opinion of that eminent author himſelf, and the grounds of it, he ſpeaks of God and the creation almoſt in the terms of St. *Paul: Proinde* (ſays he) *hæc etiam de Deo ſentienda nobis ſunt, illo quidem, ſi vim ſpectes, valentiſſimo; ſi decorem, formoſiſſimo; ſi vitam, immortali; denique, ſi virtutem, præſtantiſſimo. Quapropter cum ſit inconſpicabilis naturæ omni interituræ, ipſis nihilominus ipſe cernitur ab operibus, atque ea quidem quæ aëre quoquo modo affecto,*

Argument from authority, and the experience of all ages, that the contemplation of the world has addicted man to the reverence of God.

Libro De Mundo, cap. 6.

Alibi eodem c.

affecto, quæ in terra, quæ in aqua, ea certè Dei opera eſſe meritò dixerimus: Dei inquam opera, cum imperio ſummo mundum, ac pro poteſtate obtinentis, ex quo Deo, ut inquit Empedocles phyſicus:

Omnia quotquot erunt, quot ſunt præſentia, quotque
Orta fuere antehac ſtirpes, homineſque feræque,
Indè etiam volucres, piſceſque humoris alumni.

'Thus therefore we ought to conceive of 'God: if we conſider his power, he is omni-'potent; if his ſhape, moſt beautiful; if his 'life, immortal; and finally, if his virtue, moſt 'excellent. Wherefore though undiſcernible 'by any corruptible nature, yet he is perceived 'by ſuch in his works; and indeed thoſe things 'which are produced in the air, by any mu-'tation whatſoever, in the earth, or in the 'water, we ought deſervedly to term the 'works of God; which God is the abſolute 'and ſovereign Lord of the world, and out of 'whom (as ſaith *Empedocles* the naturaliſt,)

All things beginning have, which e'er ſhall be,
Are preſent or to come, plants, men, and beaſts,
And fowl, and fiſh the off-ſpring of the ſea.

AND thoſe few philoſophers (if ever there have been any at all) that have been really atheiſts, are no ways conſiderable for their number, in reſpect of thoſe, that have aſſerted a Deity; and their paradoxes have been looked upon as ſo irrational, that, as ſoon as they have been propoſed, they have been diſdainfully rejected and condemned by all the reſt of mankind, who have looked upon the patrons of them as monſters, rather than philoſophers. And if there be, at this day, any nations (as navigators inform us there are in *Braſil*, and ſome other parts of the *Indies*) that worſhip no God, they conſiſt not of naturaliſts, but brute, and irrational barbarians, who may be ſuppoſed rather to ignore the being of God, than deny it; and who, at leaſt, are little leſs ſtrangers to the myſteries of nature, than to the author of it. And if it be a truth, that there are really ſuch atheiſtical people, it may ſerve to recommend to us the ſtudy of phyſiology, by ſhewing us, that without the help of any ſuch innate belief, or perſuaſion of a God, as is ſuppoſed connatural to man, reaſon exerciſed upon the objects the creation preſents us with, is ſufficient to convince philoſophers of a Deity. And indeed ſuch a care has God taken, to make his being conſpicuous in his creatures, that they all ſeem loudly and unanimouſly to ſpeak to their attentive conſiderers, in the Pſalmiſt's language, *Know ye, that the Lord he is God; it is he, that hath made us, and not we our ſelves.* And as it is ſaid, *That the ſtars in their courſes fought againſt Siſera*, ſo it may be truly ſaid, that not only the ſtars, but all the reſt of the creatures do in their courſes fight againſt the atheiſt, by ſupplying an unprejudiced conſiderer of them with weapons fit to overthrow his impious error. To which purpoſe, I remember, *Ariſtotle*, in his book *de Mundo*, makes uſe of a pretty ſimile, to declare the conſpicuouſneſs of the Creator in his creatures: *Fama eſt* (ſays he) *Phidiam illum ſtatuarium, quum Minervam illam* cap. 6. *quæ eſt in arce coagmentaret, in medio ejus ſcuto faciem ſuam expreſſiſſe, oculoſque fallenti artificio ita devinxiſſe ſimulachro, eximere ut indè ipſam ſiquis cuperet, minimè poſſet, aliter quidem certè, quam ut ipſum ſolveret ſimulachrum, opuſque ejuſmodi compactile confunderet? hanc eandem rationem Deus habet in mundo, utpote qui univerſorum coagmentationem cohærentem cohibeat & coarctet, incolumitatemque univerſitatis conſervet; niſi quatenus non medio ille loco in terra ſcilicet, ubi turbida regio eſt, ſed in excelſo ſitus eſt, purus ipſe in puro loco:* 'It is reported, that when 'Phidias, the excellent ſtatuary, made the 'image of *Minerva*, which is in the caſtle at 'Athens, he contrived his own picture in the 'middle of her ſhield, and faſtened the eyes 'of it to the ſtatue by ſo cunning workman-'ſhip, that if any one were minded to take it 'away, he could not do it without break-'ing the ſtatue, and diſordering the con-'nection of the work. After the ſame man-'ner is God in the world, retaining and up-'holding the coherence of all things, and pre-'ſerving the ſafety of the univerſe: only he 'is not in the midſt of it, namely the earth, 'which is a turbulent region; but in the high-'eſt place, which is ſuitable to his purity.'

A compariſon of the image of God in the creature to that of Phidias *on* Minerva's *ſhield.*

BUT to declare, how atheiſts may be reduced either to confeſs a firſt cauſe, or to offer violence to their own faculties, by denying things as certain as thoſe, which it is apparent that (in other caſes) themſelves firmly aſſent to, would require a diſcourſe too large to be proper to be proſecuted here; and therefore if I have not, in another treatiſe, an opportunity of inſiſting on that ſubject, I muſt content my ſelf to refer you, for further ſatisfaction on it, to the writers of natural theology.

NOR does phyſiology barely conduce to make men believe the exiſtence of a Deity, but admire and celebrate the perfections of it: and the nobleſt worſhip from that greater part of the world, to which God did not vouchſafe any explicite and particular revelation of his will, hath been paid him by thoſe, whom the beauty of this goodly temple of the univerſe tranſported with a rational wonder at the wiſdom, power, and goodneſs of the divine architect. And this kind of devotion being commonly proportionate to the diſcoveries of nature, that begot it, it needs not ſeem ſtrange, that divers of the beſt philoſophers amongſt the Heathens ſhould be the greateſt celebrators of God. And it was therefore, perhaps, not without cauſe, that the Indian gymnoſophiſts, the Perſian magi, the Egyptian ſacrificers, and the old Gauls druids, were to their people both philoſophers and prieſts; and that in divers civilized nations, philoſophy and prieſthood were ſo allied, that thoſe whoſe profeſſion ſhould give them moſt intereſt in the definition of man, made a more ſtrict profeſſion of celebrating and praiſing God. I might eaſily, with divers inſtances, manifeſt, how great a veneration the ſtudy of the creatures has given philoſophers, for thoſe attributes of God, that are ſtampt upon them, and conſpicuous in them:

That thoſe people, who worſhip not God, are not naturaliſts, but barbarians; and that their atheiſm doth continue for want of the contemplation of the world.

Pſalm c 3.

Judg. v. 20.

them: but my willingneſs to haſten to the more experimental part of what I have to ſay concerning the uſefulneſs of phyſiology, makes me content my ſelf to preſent you with a couple, or a leaſh of authorities, for proof of what has been alledged: the firſt ſhall be of *Galen*, in his third book *De uſu partium*, where treating of the ſkin, that inveſts the ſoal of the foot, *Cutem ipſam* (ſays he) *non laxam, aut ſubtilem, aut mollem, ſed conſtrictam, & mediocritèr duram, ſenſilemque ut non facilè pateretur, ſubdidit pedi ſapientiſſimus Conditor noſter: cui commentarios hos, ceu hymnos quoſdam compono, & in eo pietatem eſſe exiſtimans, non ſi taurorum ἑκατόμβας ei plurimas quiſpiam ſacrificarit, & caſias aliaque ſexcenta unguenta ſuffumigarit. Sed ſi noverim ipſe primus, deindè expoſuerim aliis, quænam ſit ipſius ſapientia, quæ virtus, quæ providentia, quæ bonitas; ignorantia quorum ſumma impietas eſt, non ſi à ſacrificio abſtineas. Quod enim cultu convenienti exornavit omnia, nulliquè bona inviderit id perfectiſſimæ bonitatis ſpecimen eſſe ſtatuo. Inveniſſe autem quo pacto omnia adornarentur ſummæ ſapientiæ eſt, at effeciſſe omnia quæ voluit virtutis eſt invictæ.* 'Our moſt wiſe 'Creator hath placed under the foot a ſkin, 'not looſe, or thin, or ſoft, but cloſe, and of 'indifferent hardneſs and ſenſe, to the end it 'might not eaſily ſuffer injury. To him I 'compoſe theſe commentaries as certain hymns, 'eſteeming piety not to conſiſt in ſacrificing 'many hecatombs of oxen to him, or burning 'caſſia, and a thouſand other perfumes; but 'in this, firſt to know my ſelf, and then to 'declare to others, what his wiſdom, power, 'providence, and goodneſs is: the ignorance 'of which, not the abſtaining from ſacrifice, 'is the greateſt impiety. For I account it an 'evidence of moſt perfect goodneſs, that he 'hath furniſhed all things with convenient or'nament, and denied his benefits to none. 'Now to have deviſed, how all things might 'be handſomely framed, is the part of higheſt 'wiſdom; but to have made all things, which 'he would, of inſuperable power.' To which illuſtrious paſſage he annexes much more, worthy of *Galen*'s pen, and your peruſal.

The nobleſt worſhip, that has been paid God, from ſuch, who have not had particular revelation of his will, has aroſe from the ſpeculation of God's wiſdom, power, and goodneſs in the fabrick of the creatures.

The teſtimonies of Galen, Hermes, Paracelſus, L. Bacon.

To this let me add, in the ſecond place, that of *Hermes Triſmegiſtus*, almoſt at the very beginning of his firſt book, Engliſhed by Dr. *Everard*: *He that ſhall learn and ſtudy the things that are, and how they are ordered and governed, and by whom, and for what cauſe, or to what end, will acknowledge thanks to the workman, as to a good father, an excellent, nurſe and a faithful ſteward; and he that gives thanks ſhall be pious or religious, and he that is religious ſhall know both where the truth is, and what it is; and learning that, he will be yet more and more religious.* To which I cannot but add, a reſembling paſſage of that great Hermetical philoſopher (as his followers love to call him) *Paracelſus*: *Oppidò* (ſays he) *admirabilis, in ſuis operibus, Deus eſt; à quorum contemplatione nec interdiu, nec noctu deſiſtendum, ſed jugiter illorum indagationi vacandum eſt, hoc enim eſt ambulare in viis Dei:* 'God is very admirable in his works; from 'the contemplation of which we ought not to 'deſiſt night or day, but continually be im'ployed in the inquiſition of them: *for this is 'to walk in the ways of God.*' All which bears witneſs to, and may, in exchange, receive authority from that remarkable paſſage of that great and ſolid philoſopher, Sir *Francis Bacon*, who ſcruples not ſomewhere to affirm, 'That 'a little or ſuperficial taſte of philoſophy, may, 'perchance, incline the mind of a man to athe'iſm; but a full draught thereof brings the 'mind back again to religion. For in the en'trance of philoſophy, when the ſecond cauſes, 'which are next unto the ſenſes, do offer 'themſelves to the mind of man, and the 'mind it ſelf cleaves unto them, and dwells 'there, a forgetfulneſs of the higheſt cauſe 'may creep in: but when a man paſſeth fur'ther, and beholds the dependency, continu'ation, and confederacy of cauſes, and the 'works of providence, then, according to the 'allegory of the poets, he will eaſily believe, 'that the higheſt link of nature's chain muſt 'needs be tied to the foot of *Jupiter*'s chair: or (to ſpeak our chancellor's thoughts more ſcripturally) 'That phyſiology, like *Jacob*'s 'viſion, diſcovers to us a *ladder, whoſe top 'reaches up to the foot-ſtool of the throne of God.*' To which he deſervedly adds; *Let no man, upon a weak conceit of ſobriety, or ill-applied moderation, think or maintain, that a man can ſearch too far, or be too well ſtudied, in the book of God's word, or in the book of God's works, divinity, or philoſophy. But rather let men awake themſelves, and cheerfully endeavour and purſue an endleſs progreſs or proficiency in both; only let them beware leſt they apply knowledge to ſwelling, not to charity, to oſtentation, not to uſe: And again, that they do not unwiſely mingle and confound theſe diſtinct learnings of theology and philoſophy, and their ſeveral waters together.*

Sir Francis Bacon *Advan. of Learning*, lib. I.

Gen. xxviii.

Paracel. *de Mineral. Tract.* I.

In the fifth place, *Pyrophilus*, I conſider, that when the divines we are anſwering, ſuppoſe phyſiology likely to render a man an atheiſt, they do it (as hath above been noted already) upon this ground, that natural philoſophy may enable him to explicate both the regular phænomena, and the aberrations of nature, without having recourſe to a firſt cauſe or God. But though this ſuppoſal were as great a truth, as we have endeavoured to make it a miſtake, yet I ſee not, why a ſtudier of phyſiology, though ever ſo great a proficient in it, may rationally be an utter enemy to atheiſm. For the contemplation of the creatures is but one of the ways of coming to be convinced, that there is a God; and therefore, though religion were unable to make uſe of the argument drawn from the works of nature, to prove the exiſtence of a Deity, yet has ſhe other arguments enough beſides, to keep any conſiderate and impartial man from growing an atheiſt. And here give me leave, for the ſake of theſe divines, to obſerve, that though the devils be ſpirits, not only extremely knowing in the properties of things, (by their hidden ſkill in phyſiology, by which they teach magicians, and their other clients, to do divers of the ſtrange things for which they are admired) but alſo unmeaſurably proud, and willing to pervert their

That religion has other arguments beſides thoſe drawn from the works of nature, enough to keep any conſidering man from atheiſm.

their knowledge to the cheriſhing of atheiſm, yet St. *James* informs us, *that they themſelves believe there is a God, and tremble at him:* which argues, either, that ſkill in natural philoſophy does not neceſſarily lead to atheiſm, or that there are other arguments, beſides thoſe drawn from ſcience, ſufficient to convince the moſt refractory of the exiſtence of a Deity.

Jam. ii. 19.

BUT not to inſiſt on any thing of this nature, nor ſo much as to mention, what proofs the conſideration of our own minds, and their in-bred notions may afford us of a Deity, I ſhall content my ſelf to mind you, that the ſeveral patefactions, which God has been pleaſed to make of himſelf, to man eſpecially, thoſe made by ſeaſonably accompliſhed prophecies, and by miracles, do not only demonſtrate the being, but the providence, and divers of the attributes of God. And indeed, methinks, the divines we reaſon with, may well allow theſe patefactions to be capable of evincing the exiſtence of a God, ſince they are ſufficient, and, for aught I know, the beſt arguments we have to convince a rational man of the truth of the Chriſtian religion. For the miracles of Chriſt (eſpecially his reſurrection) and thoſe of his diſciples, by being works altogether ſupernatural, overthrow atheiſm; and being owned to be done in God's name, and to authorize a doctrine aſcribed to his inſpiration, his goodneſs and his wiſdom, permit us not to believe, that he would ſuffer ſuch numerous, great, and uncontrolled miracles, to be ſet as his ſeals to a lye, and delude men little leſs than inevitably into the belief of a doctrine not true. And as for the miracles themſelves (eſpecially that of Chriſt's reſurrection, ſo much, and ſo deſervedly inſiſted on by *Peter* to the Jews, and *Paul* to the Gentiles) the truth of them is ſo aſcertained to us by many of the ſolemneſt, and moſt authentick ways of atteſtation, whereby the certainty of matters of fact is capable of being ſatisfactorily made out, that it is hard to ſhew how theſe teſtimonies can be denied, without denying ſome acknowledged principle of reaſon, or ſome other received notion, which theſe contradictors opinions or practice manifeſt them to look upon as a truth. And upon this account, ſo much might be ſaid to evince the reaſonableneſs of aſſenting to the Chriſtian religion, and to ſhew, that as much may be ſaid for it, as need be ſaid for any religion, and much more, than can be ſaid for any other; that it need be no wonder, that, as learned men as ever the world admired, have not only been many of them embracers, but ſome of them champions of it. But having more fully, in another treatiſe, diſcourſed of this ſubject, I ſhall content my ſelf to make this inference from what has been alledged, that ſince the moſt judicious propugners of Chriſtianity have held and found, that, upon the ſcore of God's miraculous revelations of himſelf, rational men might be brought to believe the abſtruſer articles of the Chriſtian religion, thoſe revelations cannot but be ſufficient to convince them of ſo fundamental and refulgent a truth (which all the others ſuppoſe) as that of the exiſtence of God.

IN the ſixth and laſt place, I will here add (on this occaſion) that an inſight into phyſiological principles may very much aſſiſt a man to anſwer the objections of atheiſts againſt the being of a Deity, and the exceptions they make to the arguments brought to prove, that there is one. For though it has long been the cuſtom of ſuch men, to talk, as if themſelves, and thoſe of their mind, were not alone the beſt, but almoſt the only naturaliſts; and to perplex others with pretending, that, whereas it is not conceiveable, how there can be a God; all things are by the principles of the atomical philoſophy, made clear and facil: Though this, I ſay, have long been uſed among the oppoſers of a Deity, yet he, that, not regarding their confidence, ſhall attentively conſider the very firſt principles of things, may plainly enough diſcern, that of the arguments, wherewith natural philoſophy has furniſhed a heiſts, thoſe, that are indeed conſiderable, are far fewer than one would readily think; and that the difficulty of conceiving the eternity, ſelf-exiſtence, and ſome other attributes of God (though that afford them their grand objection) proceeds not ſo much from any abſurdity belonging to the notion of a Deity, as ſuch; as from the difficulty, which our dim human intellects find to concieve the nature of thoſe firſt things (whatever we ſuppoſe them) which, to be the cauſes of all others, muſt be themſelves without cauſe: for he, that ſhall attentively conſider, what the atomiſts themſelves may be compelled to allow, concerning the eternity of matter, the origin of local motion (which plainly belongs not to the nature of body) the infinity or boundleſſneſs of ſpace, the diviſibleneſs or non-diviſibility of each corporeal ſubſtance into infinite material parts, may clearly perceive, that the atomiſt, by denying, that there is a God, cannot free his underſtanding from ſuch puzzling difficulties, as he pretends to be the reaſons of his denial: for inſtead of one God, he muſt confeſs an infinite number of atoms to be eternal, ſelf-exiſtent, immortal, ſelf-moving, and muſt make ſuppoſitions, incumbred with difficulties enough to him, that has competently accuſtomed his thoughts to leave ſecond cauſes, beneath them, and contemplate thoſe cauſes, that have none. But I am unwilling to ſwell this eſſay, by inſiſting on ſuch conſiderations as theſe, eſpecially ſince you may find them more aptly deduced in other papers, ſome of which treat of the truth of Chriſtian religion, and others are deſigned for the illuſtration of ſome things in this and the foregoing eſſays. For I muſt confeſs to you, *Pyrophilus*, that by reaſon of ſundry avocations, I have been ſo diverted from propoſing ſome of the reaſons I have employed to their beſt advantage, that I my ſelf, at another time, could have both mentioned them with leſſer diſadvantage, and have added divers others: and therefore, I have not only had thoughts of enlarging upon ſome paſſages of our paſt diſcourſe, but I long ſince made a collection (though it be not now in my power) of obſervations, and experiments to elucidate a point in one of thoſe diſcourſes, whereby may be enervated one of the three chief

That the difficulty of conceiving the eternity, ſelf-exiſtence, and other attributes of one God, is leſs, than to conceive infinite eternal ſelf-exiſtent and ſelf-moving atoms.

chief phyſiological reaſonings, that I have met with, among the atheiſts.

UPON conſideration of all the premiſes, I confeſs, *Pyrophilus*, that I am inclined to think there may, perhaps, be more cauſe to apprehend, that the delightfulneſs of the ſtudy of phyſiology ſhould too much confine your thoughts and joys to the creatures, than that your proficiency in it ſhould bring you to diſbelieve the Creator. For I have obſerved it to be a fault, incident enough to ingenious perſons, to let their minds be ſo taken up, and, as it were, charmed with that almoſt infinite variety of pleaſing objects, which nature preſents to their contemplation, that they too much diſ-reliſh other pleaſures and employments, and are too apt to undervalue even thoſe, wherewith the improved opportunities of ſerving God, or holding communion with him, are capable of bleſſing the pious ſoul.

BUT, *Pyrophilus*, though comparatively to fame, and miſtreſſes, and bags, and bottles, and thoſe other tranſient, unſatisfactory, (in a word) deluding objects, on which the greateſt part of miſtaken mortals ſo fondly doat, the entertaining of our nobleſt faculties with objects ſuited to them, and proper both to gratify our curioſity, and to enrich our underſtandings, with variety of acceptable and uſeful notions, affords a ſatisfaction, that very well deſerves the choice and preference of a rational creature; yet certainly, *Pyrophilus*, as God is infinitely better than all the things, that he has made, ſo the knowledge of him is much better than the knowledge of them: and he, that has placed ſo much delightfulneſs in a knowledge, wherein he allows his very enemies to become very great proficients, has ſure reſerved much higher, and more contenting pleaſures to ſweeten and endear thoſe diſcloſures of himſelf, which he vouchſafes to none but thoſe that love him, and are loved by him.

As God is infinitely better than all his creatures, ſo the knowledge of him is better than the knowledge of his creatures.

AND therefore, *Pyrophilus*, though I will allow you to expect from the contemplation of nature a greater ſatisfaction, than from any thing you need decline for it, yet I would not have you expect from it any ſuch ſatisfaction as you may entirely acquieſce in; for nothing but the enjoyment of him, that made the ſoul for himſelf, can ſatisfy it, the creatures being as well uncapable to afford us a complete felicity by our intellectual ſpeculations of them, as by our ſenſual fruitions of them. For though the knowledge of nature be preferable by odds to thoſe other idols, which we have mentioned, as inferiour to it, yet we here attain that knowledge but very imperfectly, and our acquiſitions of it coſt us ſo dear, and the pleaſure of them is ſo allayed with the diſquieting curioſity they are wont to excite, that the wiſeſt of men, and greateſt of philoſophers among the ancients, ſcruples not, upon his own experience, to call the addicting of *one's heart to ſeek and ſearch out by wiſdom, concerning all things that are done under the heaven, a ſore travel given by God to the ſons of men; to be exerciſed* (or, as the original hath it, *to afflict themſelves*) *therewith*. And the ſame experienced writer elſewhere tells us, *That he that increaſes knowledge, increaſes ſorrow*. And it was perhaps for this reaſon, that *Adam* was formed out of paradiſe, and afterwards by God brought into it, to intimate, that felicity is not a thing, that man can acquire for himſelf, but muſt receive as a free gift from the liberal hand of God. And as the children of the prophets ſought tranſlated *Elias* with very great diligence, but with no ſucceſs, ſo do we, as fruitleſly as induſtriouſly, ſeek after perfect happineſs here, both they and we miſſing of what we ſeek, for the ſame reaſon; becauſe we ſeek for that on earth, which is not to be found but in heaven. And this I forewarn you of, *Pyrophilus*, not at all to diſcourage you from the ſtudy of phyſiology, but to keep you from meeting with that great diſcouragement of finding in it much leſs of ſatisfaction than you expected; an over-great expectation from it being one of the diſadvantagiouſeſt circumſtances with which it is poſſible for any thing to be enjoyed.

The imperfection and diſquiet, that there is in human ſcience.

Eccleſ. i. 13.

Eccleſ. i. 18.

2 King. cap. ii.

BUT at length, *Pyrophilus*, though late, I begin to diſcern, into how tedious a digreſſion my zeal for natural philoſophy, and for you, has miſ-led me, and how it has drawn from my pen ſome paſſages, which may ſeem to reliſh more of the preacher, than the naturaliſt; yet I might alledge divers things to juſtify, or, at leaſt, extenuate what I have done: as firſt, that if in making this excurſion I have erred, I have not done ſo without the authority of great examples. For not only *Seneca* doth frequently both ſeaſon his natural ſpeculations with moral documents and reflexions, and owns, that he purpoſely does ſo, where he ſays, *Omnibus rebus, omnibuſque ſermonibus aliquid ſalutare miſcendum eſt, cum imus per occulta naturæ, &c.* But even *Pliny* (as far as he was from being guilty of over-much devotion) does, from divers paſſages in his Natural Hiſtory, allow himſelf to take occaſion to inveigh againſt the luxury, exceſſes, and other epidemical vices of his time. And I might next repreſent, that perhaps the endeavouring to manifeſt, that the knowledge of the creatures ſhould, and how it may be referred to the Creator's glory, is not altogether impertinent to the deſign I have of promoting phyſiology; for it ſeems conſonant both to God's goodneſs, and that repeated axiom in the goſpel, which tells us, *that he, that improves his talents to good uſes, ſhall be intruſted with more*; that the imploying the little knowledge I have in the ſervice of him I owe it to, may invite him to increaſe that little, and make it leſs deſpicable. And perhaps it is not the leaſt cauſe of our ignorance, in natural philoſophy itſelf, that when we ſtudy the great book of nature, called the Univerſe, we conſult, peradventure, almoſt all other expoſitors to underſtand its myſteries, without making any addreſs for inſtruction to the author, who yet is juſtly ſtyled in the ſcripture, *that Father of lights* (in the plural number) *from whom deſcends every good and every perfect gift*; not only thoſe ſupernatural graces, that relate to another world, but thoſe intellectual endowments, that qualify men for the proſperous contemplation of this: and therefore in the evangelical prophet, he is ſaid, to inſtruct Iſa xxviii. even 25, 26.

Seneca *nat. quæſt.* lib. 2. cap. 59.

How the favour of God contributes to promote men's proficiency in the ſtudy of nature.

Jam i. 17.

even the plough-man, and teach him the ſkill and underſtanding he diſplays in his own profeſſion. And though I dare not affirm, with ſome of the Helmontians and Paracelſians, that God diſcloſes to men the great myſtery of chymiſtry by good angels, or by nocturnal viſions, as he once taught *Jacob*, to make
Gen. xxxi. lambs and kids come into the world ſpeckled, and ring-ſtreaked; yet perſuaded I am, that the favour of God does (much more than moſt men are aware of) vouchſafe to promote ſome men's proficiency in the ſtudy of nature, partly by protecting their attempts from thoſe unlucky accidents, which often make ingenuous and induſtrious endeavours miſcarry; and partly by making them dear and acceptable to the poſſeſſors of ſecrets, by whoſe friendly communication they may often learn that in a few moments, which coſt the imparters many a year's toil and ſtudy; and partly too, or rather principally, by directing them to thoſe happy and pregnant hints, which an ordinary ſkill and induſtry may ſo improve, as to do ſuch things, and make ſuch diſcoveries by virtue of them, as both others, and the perſon himſelf, whoſe knowledge is thus increaſed, would ſcarce have imagined to be poſſible: and in effect, the chiefeſt of the ſecrets, that have been communicated to me, the owners have acknowledged to me to have been attained, rather, as they were pleaſed to ſpeak, by accidental hints, than accurate inquiries: conceſſions of this nature I have divers times met with in the writings of the more ingenious of the chymiſts, and of other naturaliſts, and by one of theſe accidental hints, of late, the acute and lucky *Pecquet* was directed to find the newly diſcovered *lactea thoracica*, as before him *Aſellius* found without ſeeking, as himſelf confeſſeth, the *lactea meſenterica*; and by an accident too (as himſelf hath told me) did our induſtrious anatomiſt, Dr. *Jolive*, firſt light upon thoſe yet more freſhly detected veſſels, which afterwards the ingenious *Bartholinus*, without being informed of them, or ſeeking for them, hath met with, and acquainted the world with, under the name of *vaſa lymphatica*; and the two great inventions of the latter ages, gunpowder, and the loadſtone's reſpect unto the poles, are ſuppoſed to be due rather to chance, than any extraordinary ſkill in philoſophical principles (which indeed would ſcarce have made any man dream of ſuch extravagant properties, as thoſe of magnetick bodies) as if God deſigned to keep philoſophers humble, and (though he allow regular induſtry, ſufficient encouragment, yet) to remain himſelf diſpenſer of the chief myſteries of nature.

To what hath been repreſented, *Pyrophilus*, I might add much more to excuſe my excurſions, if I were not content to be beholden to you for a pardon; and to invite you to grant it me, I ſhall promiſe you to be very careful not to repeat the like offence. And whereas moſt chymical writers take occaſion, from almoſt every diſcovery or proceſs they acquaint us with, to digreſs and wander into tedious, and too often dull and impertinent theological reflections or ſermons; I have troubled you with almoſt all that I have to ſay (to you) of theological at once, and I have endeavoured to ſprinkle it, as far the ſubject would allow me, with ſome paſſages experimental. And indeed I ſhould not at all have engaged my ſelf into ſo long a diſcourſe of the not only innocency, but uſefulneſſes of the knowledge of nature, in reference to religion, but that I could not acquieſce in what I had met with on that ſubject in any of the writers I have peruſed, divines being commonly too unacquainted with nature, to be able to manage it phyſiologically enough, and naturaliſts commonly eſteeming it no part of their work to treat of it at all. And therefore I ſcruple not to confeſs freely to you, *Pyrophilus*, that, as I ſhall think my ſelf richly rewarded for all the enſuing eſſays, if the paſt diſcourſe but prove ſo happy as to bring you to value, and to make the religious uſe of the creatures recommended to you in it; ſo I had rather any of my papers ſhould be paſſed by unperuſed, than thoſe parts of theſe eſſays, that treat of that uſe. And indeed it is none of the leaſt of ſatisfactions I hope to derive from my phyſical compoſures, that by premiſing before them the now almoſt finiſhed diſcourſe, I have done my hearty endeavour to manifeſt and recommend the true uſe of all the diſcoveries of nature, which either my inquiries, or your own, may afford you. And indeed for my part, *Pyrophilus*, I eſteem the doctrine I have been pleading for of that importance, that I am perſuaded, that he, that could bring philoſophical devotion into the requeſt it merits, would contribute as much to the ſolemnizing of God's praiſes, as the benefactors of choriſters and founders of chauntries, and not much leſs than *David*'s ſo celebrated deſignation and ſettlement of that religious Levitical muſick, inſtituted for the ſolemn celebration of God.

The reaſon of the author's ſo long diſcourſe on this ſubject.

FOR the ſenſible repreſentations of God's attributes to be met with in the creatures, occurring almoſt every where to our obſervation, would very aſſiduouſly ſollicit us to admire him, did we but aright diſcern him in them; and the impreſſions made on the mind by theſe repreſentations, proceeding not from a bare (and perhaps languid) whether belief or notion of the perfections expreſſed in them, but from an actual and operative intuition of them, would excite an admiration (with the devotion ſpringing thence) by ſo much the more intenſe, by how much (it would be) more rational. And ſure, *Pyrophilus*, ſo much admirable workmanſhip, as God hath diſplayed in the univerſe, was never meant for eyes that wilfully cloſe themſelves, and affront it with the not judging it worthy the ſpeculating. Beaſts inhabit and enjoy the world; man, if he will do more, muſt ſtudy, and (if I may ſo ſpeak) ſpiritualize it. It is the firſt act of religion, and equally obliging in all religions: it is the duty of man, as man; and the homage we pay for the privi-
ledge of reaſon; which was given us, not only to refer our ſelves, but the other creatures, that want it, to the Creator's glory. Which makes me ſometimes angry with them, who ſo buſy themſelves in the duties and imployments

Beaſts inhabit and enjoy the world, it is man's duty to ſpiritualize it.

That it being the prime duty of man to give God the honour of his creatures, it is to be preferred before ſecondary duties.

of their ſecond and ſuperinduced relations, that they will never find the leiſure to diſcharge that primitive and natural obligation, who are more concerned as citizens of any place, than of the world; and both worſhip God ſo barely as Catholick or Proteſtants, Anabaptiſts or Socinians, and live ſo wholly as lords or councellors, Londoners or Pariſians, that they will never find the leiſure, or conſider not, that it concerns them to worſhip and live as men. And the neglect of this philoſophical worſhip of God, for which we are pleading, ſeems to be culpable in men proportionably to their being qualified, and comply with that invitation of the Pſalmiſt, *to ſing praiſes to God with underſtanding*, or (the expeſſion in the original being ſomewhat ambiguous) *to ſing to him a learned canticle*, as he elſewhere ſpeaks, *to praiſe him according to his excellent greatneſs*. For knowledge being a gift of God, intruſted to us to glorify the giver with it, the greatneſs of it muſt aggravate the neglect of imploying it gratefully; and the ſublimeſt knowledge here attainable will not deſtroy, but only heighten and enoble our admiration, and will prove the incenſe or more ſpiritual and acceptable part of that ſacrifice of praiſe, (for thoſe reflections, which their nature makes only acts of reaſon, their end may make acts of piety) wherein the intelligent admirer offers the whole world in eucharists to its Maker. For admiration (I do not ſay aſtoniſhment or ſurprize) being an acknowledgment of the objects tranſcending our knowledge, the learneder the tranſcendent faculty is, the greater is the admired object's tranſcendency acknowledged. And certainly, God's wiſdom is much leſs glorified by the vulgar aſtoniſhment of an unlettered ſtarer, (whoſe ignorance may be as well ſuſpected for his wonder, as the excellency of object) than from their learned hymns, whoſe induſtrious curioſity hath brought their underſtandings to a proſtrate veneration of what their reaſon, not ignorance, hath taught them not to be perfectly comprehenſible by them.

Pſal. xlvii. 7.

Pſal. cl. 2.

And as ſuch perſons have ſuch piercing eyes, that where a tranſient or unlearned glance ſcarce obſerves any thing, they can diſcern an adorable wiſdom, being able (as I may ſo ſpeak) to read the ſtenography of God's omniſcient hand; ſo their ſkilful fingers know how to chuſe and how to touch thoſe ſtrings, that may ſound ſweeteſt to the praiſe of their Maker. And on the opened body of the ſame animal, a ſkilful anatomiſt will make reflections, as much more to the honour of its Creator, than an ordinary butcher can; as the muſick made on a lute, by a rare lutaniſt, will be preferable to the noiſe made on the ſame inſtrument by a ſtranger unto melody. And give me leave to tell you, *Pyrophilus*, that ſuch a reaſonable worſhip (λογικὴ λατρεία) of God (to uſe St. *Paul*'s expreſſion, though in another ſenſe) is perhaps a much nobler way of adoring him, than thoſe, that are not qualified to practiſe it, are aware of, and is not improper even for Chriſtians to exerciſe. For, *Pyrophilus*, it would be conſidered, that as God hath not, by becoming (as the Scripture more than once ſtyles him) our Saviour, laid by his firſt relation to us as our Creator (whence St. *Peter* exhorts, even the ſuffering Chriſtians of his time, to commit their ſouls to God under the notion of a faithful Creator) ſo neither hath he given up his right to thoſe intelligent adorations from us, which become us upon the account of being his rational creatures: neither are ſuch performances made leſs acceptable to him by the filial relation, into which Chriſt hath brought us to him; that glorious relation as well endearing to him our ſervices, as our perſons.

That the different greatneſs in the knowledge makes a like difference in the honour given to the Creator.

Rom. xii. 1.

1 Tim. i. 1. Tit. ii. 10.

1 Pet. iv. 19.

God, by becoming our Saviour, has not laid aſide the relation of a Creator.

And let me add, *Pyrophilus*, that not only *Galen* (as we have ſeen already) tells us, that the diſcerning one's ſelf, and diſcovering to others the perfections of God diſplayed in the creatures, is a more acceptable act of religion, than the burning of ſacrifices or perfumes upon his altars: and not only *Triſmegiſtus*, forbidding *Aſclepius* to burn incenſe, tells him, 'That the thanks and praiſes of men, are the 'nobleſt incenſe that can be offered up to God:' But God himſelf (in his written word) is pleaſed to ſay, *That he, that ſacrificeth praiſe* (for ſo it is in the original) *honoureth him*. And the Scripture conſonantly mentions as a very acceptable part of religious worſhip, the *ſacrifice of praiſe, and the calves of our lips:* by offering up of which, we make that true uſe of the creatures, of ſo referring them to their Creator's glory, that (to conclude this diſcourſe by crowning it, as it were, with that excellent circle mentioned by the Apoſtle) as *all things are of him, and through him*, ſo they may be *to him; to whom be glory for ever*, Amen.

That he, who ſacrificeth praiſe, honoureth God.

Hermet Triſm. in Aſclep. c. 15.

The concluſion.

Heb. xiii. 15.

Rom. xi. 36.

OF

OF THE USEFULNESS OF NATURAL PHILOSOPHY.

PART II.

SECT. I.
Of its Uſefulneſs to PHYSICK.

ESSAY I.
Containing ſome particulars tending to ſhew the Uſefulneſs of Natural Philoſophy to the Phyſiological Part of Phyſick.

AFTER having, in the former part of this treatiſe, *Pyrophilus*, thus largely endeavoured to manifeſt to you the advantageouſneſs of natural philoſophy to the mind of man, we ſhall now proceed to ſpeak of its uſefulneſs both to his body and fortune.

The advantage of the knowledge of nature towards the increaſing the power of man; and its uſe as to health of the body and goods of fortune.

For I muſt ingeniouſly confeſs to you, *Pyrophilus*, that I ſhould not have near ſo high a value as I now cheriſh for phyſiology, if I thought it could only teach a man to diſcourſe of nature, but not at all to maſter her; and ſerved only, with pleaſing ſpeculations to entertain his underſtanding, without at all increaſing his power. And though I preſume not to judge of other men's knowledge; yet, for my own particular, I ſhall not dare to think my ſelf a true naturaliſt, till my ſkill can make my garden yield better herbs and flowers, or my orchard better fruit, or my field better corn, or my dairy better cheeſe, than theirs that are ſtrangers to phyſiology. And certainly, *Pyrophilus*, if we ſeriouſly intend to convince the diſtruſtful world of the real uſefulneſs of natural philoſophy, we muſt take ſome ſuch courſe, as that Mileſian *Thales* did, who was by the antients reckoned among the very firſt of their naturaliſts, and their ſeven celebrated wiſe men. Of this *Thales* it is reported, that being upbraidingly demanded, what advantage the profeſſors of aſtrology could derive from the knowledge of it; he aſtrologically foreſeeing what a year it would prove for olives, before any wonted ſigns of it did appear to huſbandmen, ingroſſed, by giving earneſt, the greater part of the olives, which the next ſeaſon ſhould afford to *Chios* and *Miletus*; and being thereby enabled, when moſt men wanted oil, to ſell his at his own rates, he made advantage enough of his ſkill, to let his friends ſee, that philoſophers may have the acquiſition of wealth more in their power than in their aim.

That in man's knowledge of the nature of creatures, conſiſts his empire over them.

METHINKS, it ſhould be a diſparagement to a philoſopher, when he deſcends to conſider huſbandry, not to be able, with all his ſcience, to improve the precepts of an art, reſulting from the lame and unlearned obſervations and practice of ſuch illiterate perſons as gardeners, plowmen, and milkmaids. And indeed, *Pyrophilus*, though it be but too evident, that the barren philoſophy, wont to be taught in the ſchools, hath hitherto been found of very little uſe in human life; yet if the true principles of that fertile ſcience were thoroughly known, conſidered, and applied, it is ſcarce imaginable, how univerſal and advantageous a change they would make in the world. For in man's knowledge of the nature of the creatures, doth principally conſiſt his empire over them, (his knowledge and his power having generally the ſame limits.) And as the nerves, that move the whole body, and by it, that great variety of engines imployed by man on his manifold occaſions, proceed from the brain; ſo all the operations, by which we alter nature, and produce ſuch changes in the creatures, flow from our knowledge of them. Theological inquiries excepted, there is no imployment, wherein mankind is ſo much and ſo generally concerned, as it is the ſtudy of natural philoſophy. And thoſe great tranſactions, which make ſuch a noiſe in the world, and eſtabliſh monarchies or ruin empires, reach not ſo many perſons with their influence, as do the theories of phyſiology.

That the diſcovery of America is owed to the knowledge of the loadſtone's polarity.

That the martial affairs all over the world were altered by the knowledge of the nature of brimſtone and ſaltpetre.

To manifeſt this truth, we need but conſider, what changes in the face of things have been made by two diſcoveries, trivial enough; the one being but of the inclination of the needle, touched by the loadſtone, to point toward the pole; the other being but a caſual diſcovery of the ſuppoſed antipathy between ſalt-petre, and brimſtone: for without the knowledge of the former, thoſe vaſt regions of *America*, and all the treaſures of gold, ſilver, and precious ſtones, and much more precious ſimples they ſend us, would have probably continued undetected; and the latter giving an occaſional riſe to the invention of gunpowder, hath quite altered the condition of martial affairs over the world, both by ſea and land. And certainly, true natural

natural philoſophy is ſo far from being a barren ſpeculative knowledge, that phyſick, huſbandry, and very many trades (as thoſe of tanners, dyers, brewers, founders, *&c.*) are but corollaries or applications of ſome few theorems of it.

How prejudicial the miſtake of that aphoriſm (that if teeming women be let blood, they will miſcarry) *hath been to female patients.*

IF I had not a great reſpect for the great *Hippocrates*, I ſhould venture to ſay, that ſome of thoſe rigid laws of *Draco* (whoſe ſeverity made men ſay, that they were written in blood) have, perhaps, coſt fewer perſons their lives, than that one aphoriſm of *Hippocrates*, which teaching, 'That if a teeming 'woman be let blood, ſhe will miſcarry,' has for divers ages prevailed with great numbers of phyſicians, to ſuffer multitudes of their female patients to die under their hands, who might probably have been reſcued by a diſcreet phlebotomy, which experience hath aſſured us (whatever the cloſe of the aphoriſm ſays to the contrary) to have been ſometimes not only ſafely, but uſefully employed, even when the infant is grown pretty big. But my reſpect for ſo great a perſon as *Hippocrates* makes me content it ſhould be thought, that, till of late, phyſicians have for the moſt part miſtaken their dictator's meaning in this aphoriſm, provided it be granted me, that through this miſtake numbers of teeming women have been ſuffered to periſh, who might probably, by the ſeaſonable loſs of ſome of their blood, have prevented that of their lives.

AND if an error, which occaſioned only a fault of omiſſion, hath been ſo prejudicial to mankind, I ſuppoſe you will readily grant, that thoſe errors of phyſicians, that are apt to produce faults of commiſſion, and raſh attempts, may prove much more hurtful. And ſo much I find to be acknowledged by *Galen*, in that honeſt and excellent paſſage of his, in his *Comment upon the Aphoriſms*, where having mentioned the danger of trying concluſions upon men, by reaſon of the nobleneſs of the ſubject; and having added, that the phyſician's art is not like that of a potter, a carpenter, or the like, where a man may freely try what he pleaſes to gratify his curioſity, or ſatisfy himſelf about his notions, becauſe, that if he ſpoils (for inſtance) the wood he works on, no body is indangered by his miſcarriage; he thus concludes, *In corpore autem humano ea tentare, quæ non ſunt experientium comprobata periculo, non vacat; cùm temerariæ experientiæ finis ſit totius animantis internecio*; 'But I dare not try 'thoſe things upon human body, which have 'not been before tried upon former experi-'ences; for the end of ſuch raſh experiments 'may be the ruin of all lives.'

Comment. in Aph. I. Lib. I.

The intereſt of this knowledge to the happineſs and life of man.

AND indeed, ſince the phyſician borrows his principles of the naturaliſt, I cannot but ſomewhat admire to ſee divers perſons, who are by themſelves and others thought ſuch wiſe men, think the ſtudy of natural philoſophy of ſmall concernment: for when by their policy or good fortune, they have acquired never ſo much wealth or power, and all other tranſitory goods, and are bleſt with children to inherit them, if the principles of natural philoſophy be miſlaid, we oftentimes ſee the ignorance or the miſtake of a doctor, deprive them of all at once, and ſhew how dangerous it is to be ſollicitous of the means of attaining the accommodations of life, with the contempt of that knowledge, which in very many caſes is humanly neceſſary to the preſervation of life it ſelf.

BUT, *Pyrophilus*, though our unintended prolixity in the former part of our diſcourſe, concerning the uſefulneſs of phyſiology, oblige us to the greater brevity in this latter part of it; yet, to ſhew you, that of the two things, which you may remember we told you, *Pythagoras* pronounced moſt god-like in man, *(The knowledge of truth, and the doing of good,)* phyſiology as well qualifies us for the latter, as it inriches us with the former. It will not be amiſs a little more particularly (though as ſuccinctly as ſo copious a ſubject will permit) to conſider the probability there is, that no ſmall improvement may be made by men's proficiency in experimental knowledge of thoſe arts, which are the chiefeſt inſtruments of man's dominion over the creatures. Theſe arts (to divide them not accurately, but popularly) do ſerve either to relieve man's neceſſities, as phyſick and huſbandry; or for his accommodation, as the trades of ſhoe-makers, dyers, tanners, *&c.* or for his delight, as the trades of painters, confectioners, perfumers, *&c.* to all which arts, and many others allied to them, philoſophical experiments and obſervations may, by a knowing naturaliſt, be made to extend a meliorating influence.

The enumeration of thoſe arts, to which this knowledge is profitable

IF I ſhould, *Pyrophilus*, ſay this, without offering any thing at all by way of proof, that I ſay it not inconſiderately, you would, I fear, believe, that I deliver it too ſlightly for a matter of that moment: and if, on the other ſide, I ſhould in this diſcourſe, preſent to you all the particulars, that I think I could without impertinency employ, to countenance what I have ſaid, it would ſwell this treatiſe to a volume, and defraud divers of my other eſſays. And therefore I hold it not unfit to chuſe a middle way, and ſet down, on this occaſion, either only, or chiefly thoſe things, which do the moſt readily occur to me, and do not ſo properly belong to the reſt of my phyſiological papers. And to avoid confuſion, I ſhall, according to the diviſion newly propoſed, employ one ſection of this ſecond part of the preſent treatiſe, in ſetting down ſuch things, as relate to the improvement of phyſick. And in the other ſection, deliver ſuch particulars, as concern thoſe other uſeful arts, that depend upon natural philoſophy. But in regard that (as I have already intimated) the following diſcourſe is to conſiſt chiefly of thoſe things, that belong not to any of my other eſſays, you will not, I preſume, expect that I ſhould handle any ſubject fully or methodically on this occaſion: which warning I eſpecially intend for that part of the enſuing diſcourſe, that relates to phyſick. For you will eaſily believe, that I am far from pretending to be a doctor in that faculty: and accordingly, in this and the four following eſſays, I ſhall only throw together divers ſuch particulars, as, not belonging

The method or way intended for the enſuing diſcourſe

to

* *Hipp. Aph.* Lib. V. Γυνὴ ἐν γαστρὶ ἔχουσα, φλεβοτομωθεῖσα ἐκτιτρώσκει· ϗ μᾶλλον εἰ μείζου εἴη τὸ ἔμβρυον.

to my writing, would perhaps be loſt, if I did not lay hold on this opportunity for their preſervation; of which they are not altogether judged unworthy by ſome knowing men, whoſe encouragements, to mention them to you, have diſſuaded me from wholly paſſing by, in this diſcourſe, matters properly medical, what ſcruples ſoever I had to venture at ſpeaking of them: eſpecially ſince I have not now the conveniency to furniſh theſe eſſays with divers particulars (by ſome, thought not inconſiderable,) which I may, perhaps, be invited to add to them hereafter, if I find by your reception of theſe, that the others are like to be welcome.

The diviſion of phyſick in five parts.

To ſay ſomething then of phyſick, and to ſuppoſe the fitneſs of the now received diviſion of it into five parts; the phyſiological, (the phyſician taking that in a ſtricter ſenſe than philoſophers, and than we do every where, ſave in this eſſay) pathological, ſemeiotical, hygieinal, and therapeutical; let us briefly take notice, how each of theſe is indebted to, or capable of being improved by experienced naturaliſts. And indeed, ſuch is the affinity between natural philoſophy and phyſick, or the dependance of this on that, that we need not wonder at the judicious obſervation of *Ariſtotle*, where he thus writes, *Naturalium ferè plurimis & medicorum, qui magis philoſophicè artem proſequuntur, illi quidem finiunt ad ea, quæ de medicina; hi vero ex iis quæ de natura, incipiunt quæ de medicina:* 'This is the 'courſe of naturaliſts and phyſicians, who pro-'ſecute their art philoſophically: the naturaliſt 'ends where medicine begins, and medicine 'begins where the naturaliſt endeth.' But we muſt inſtance theſe things more particularly: and firſt for phyſiology, it is apparent, that the phyſician takes much of his doctrine in that part of his art from the naturaliſt: and to mention now no other parts of phyſiology, in its ſtricter acception, the experience of our own age may ſuffice to manifeſt, what light the anatomical doctrine of man's body may receive from experiments made on other ſubjects. For ſince it were too barbarous, and too great a violation of the laws, not only of divinity but humanity, to diſſect human bodies alive, as did *Herophilus* and *Eraſiſtratus*, who (as I find in ſome of the ancients) obtained of kings the bodies of malefactors for that purpoſe, and ſcrupled not to deſtroy man to know him; and ſince, nevertheleſs, divers things in anatomy, as particularly the motion of the blood and chyle cannot be diſcovered in a dead diſſected body (where the cold hath ſhut up and obliterated many paſſages) that may be ſeen in one opened alive; it muſt be very advantageous to a phyſician's anatomical knowledge, to ſee the diſſections of dogs, ſwine, and other live creatures, made by an inquiſitive naturaliſt: conſonantly whereunto we may remember, that the diſcoveries of the milky veſſels in the meſentery by *Aſellius*, of thoſe in the thorax by *Pecquet*, and of the *vaſa lymphatica* by *Bartholinus*, were firſt made in brute bodies, though afterwards found to hold in human ones. Nor is it a ſmall convenience to the anatomiſt, that he may in the bodies of brutes make divers inſtructive experiments, that he dares not venture on in thoſe of men; as for inſtance, that late noble, and by many not yet credited experiment, of taking out the ſpleen of a dog without killing him: for that this experiment may be very uſeful, we may elſewhere have occaſion to ſhew. And that it is poſſible to be ſafely made (though many, I confeſs, have but unproſperouſly attempted it, and it hath been lately pronounced impoſſible in print) ourſelves can witneſs. And becauſe I have not yet met with any author, that profeſſes himſelf not to relate this experiment (of the exemption of a dog's ſpleen) upon the credit of others, but as an eye-witneſs; I am content to aſſure you, that that dextrous diſſector, Dr. *Jolive* (of whom we formerly made mention) did the laſt year, at my requeſt, take out the ſpleen of a young ſetting-dog I brought him: and that it might not be pretended, the experiment was unfaithfully or favourably made, I did part of it myſelf, and held the ſpleen (which was the largeſt in proportion to his body, that ever I ſaw) in my hand, whilſt he cut aſunder the veſſels reaching to it, that I might be ſure there was not the leaſt part of the ſpleen left unextirpated: and yet this puppy, in leſs than a fortnight, grew not only well, but as ſportive and as wanton as before; which I need not take pains to make you believe, ſince you often ſaw him at your mother's houſe, whence at length he was ſtolen. And though I remember the famous empirick *Fioravanti*, in one of his Italian books, mentions his having been prevailed with by the importunity of a lady (whom he calls *Marulla Græca*) much afflicted with ſplenetick diſtempers, to rid her of her ſpleen; and adds, that ſhe out-lived the loſs of it divers years: yet he, that conſiders the ſituation of that part, and the conſiderableneſs of veſſels belonging to it in human bodies, will probably be apt to think, that though his relation may be credited, his venturouſneſs ought not to be imitated. The experiment alſo of detaining frogs under water for very many hours (ſometimes amounting to ſome days) without ſuffocation, may, to him, that knows that frogs have lungs and breathe as well as other terreſtrial animals, appear a conſiderable diſcovery, in order to the determining the nature of reſpiration. Beſides, the ſcrupulouſneſs of the parents or friends of the deceaſed perſons deprives us oftentimes of the opportunities of anatomizing the bodies of men, and much more thoſe of women; whereas thoſe of beaſts are always and every where to be met with. And it was perhaps, upon ſome ſuch account, that *Ariſtotle* ſaid, that the external parts of the body were beſt known in men, the internal in beaſts; *Sunt enim* (ſays he, ſpeaking of the inward parts) *hominum imprimis incertæ atque incognitæ; quamobrem ad cæterorum animalium partes, quarum ſimiles ſunt humanæ, referentes eas contemplari debemus.* 'The parts of hu-'man body are unknown, and therefore we 'ought to conſider them by the parts of other 'animals, to which they are like.' And queſtionleſs in many of them, the frame of

Ariſt. lib. de ſenſu & ſenſili, cap. 1.

How the phyſiological part of phyſick is advantaged by the knowledge of natural philoſophy.

That the anatomical doctrine of man's body receives light from experiments made on other creatures.

Proved by divers inſtances: as of the finding the lacteals and lymphæ-ducts in brute bodies firſt.

The experiment of taking out the ſpleen in dogs.

The ſame thing done by Fioravanti in a woman.

The reſpiration of frogs divers hours, ſometimes days, under water, without ſuffocation.

Ariſt. *Hiſt.* lib. 1. cap. 16.

the parts is ſo like that of thoſe anſwerable in men, that he that is but moderately ſkilled in androtomy (as ſome of the moderns call the diſſection of man's body, to diſtinguiſh it from zootomy, as they name the diſſections of the bodies of other animals) may, with due diligence and induſtry, not deſpicably improve his anatomical knowledge. In confirmation of which truth, give me leave to obſerve to you, that though *Galen* hath left to us ſo many, and by phyſicians ſo much magnified anatomical treatiſes; yet not only divers of thoſe modern phyſicians, that would eclipſe his glory, deny him to have learned the ſkill he pretends to, out of the inſpection of the diſſected bodies of men or women, or ſo much as to ever have ſeen a human anatomy. But I find, even among his admirers, phyſicians, that acknowledge, that his knives were much more converſant with the bodies of apes, and other brutes, than with thoſe of men, which in his time, thoſe authors ſay, it was thought little leſs than irreligious, if not barbarous, to mangle; which is the leſs to be wondered at, becauſe even in this our age, that great people of the Muſcovites, though a Chriſtian and European nation, hath denied phyſicians the uſe of anatomy and ſkeletons; the former, as an inhuman thing; the latter, as fit for little but witchcraft, as we are informed by the applauded writer *Olearius*, ſecretary to the embaſſy lately ſent by that learned prince, the preſent duke of *Holſtein*, into *Muſcovia* and *Perſia*. And of this, the ſame author gives us the inſtance of one *Quirin*, an excellent German chirurgeon, who, for having been found with a ſkeleton, had much ado to eſcape with his life, and was commanded to go out of the kingdom, leaving behind him his ſkeleton, which was alſo dragged about, and afterwards burnt.

What uſe Ariſtotle and Galen made of the diſſections of brutes.

Anatomy of man counted now in Muſcovy for inhuman; and the uſe of skeletons for witchcraft.

Voyage de Muſcovie & de Perſe, p. 128.

To theſe things we may add, *Pyrophilus*, that the diligence of zootomiſts may much contribute to illuſtrate the doctrine of androtomy, and both inform phyſicians of the true uſe of the parts of an human body, and help to decide divers anatomical controverſies. For as in general it is ſcarce poſſible to learn the true nature of any creature, from the conſideration of the ſingle creature it ſelf; ſo particularly of divers parts of an human body it is very difficult to learn the true uſe, without conſulting the bodies of other animals, wherein the parts inquired after is by nature either wholly left out as needleſs, or wherein its differing bigneſs, or ſituation, or figure, or connection with, and relation to other parts, may render its uſe more conſpicuous, or at leaſt, more diſcernible.

The uſe of the compariſon of the parts of human body, with thoſe of beaſts.

Illuſtrated by divers particular obſervations.

THIS truth may be ſomewhat illuſtrated by the following obſervations, which at preſent offer themſelves to my thoughts upon this occaſion.

THE lungs of vipers, and other creatures (whoſe hearts and whoſe blood, even whilſt it circulates, we have always found, as to ſenſe, actually cold) may give us juſt occaſion to inquire a little more warily, whether the great uſe of reſpiration be to cool the heart.

THE ſudden falling and continuing together, which we may obſerve in that part at leaſt of a dog's lungs, that lie on the ſame ſide with the wound, upon making a large wound in his cheſt, though the lungs remain untouched, is a conſiderable experiment, in order to the diſcovery of the principal organ of reſpiration.

IF you dexterouſly take out the hearts of vipers, and of ſome ſmaller fiſhes, whoſe coldneſs makes them beat much more unfrequently and leiſurely, than thoſe of warm animals, the contraction and relaxation of the fibres of the heart may be diſtinctly obſerved, in order to the deciding or reconciling the controverſy about the cauſe and manner of the heart's motion, betwixt thoſe learned modern anatomiſts, that contend, ſome of them, for Dr. *Harvey*'s opinion; and others, for that of the Carteſians.

TOWARDS ſatisfying my ſelf in which difficulty, I remember, I have ſometimes taken the heart of a flounder, and having cut it tranſverſly into two parts, and preſſed out, and with a linnen cloth wiped off, the blood contained in each of them, I obſerved, that for a conſiderable ſpace of time, the ſever'd and bloodleſs parts held on their former contraction and relaxation. And once, I remember, that I obſerved, not without wonder, that the ſever'd portions of a flounder's heart did, not only after the blood was drained, move as before, but the whole heart obſerved for a pretty while ſuch a ſucceſſion of motion in its divided and exſanguious pieces, as I had taken notice of in them, whilſt they were coherent, and as you may with pleaſure both ſee and feel in the intire heart of the ſame fiſh.

SOME of the other controverſies agitated among anatomiſts and philoſophers, concerning the uſe of the heart, and concerning the principal ſeat of life and ſenſe, may alſo receive light from ſuch experiments, that we made in the bodies of brutes, as we could not of men.

AND the firſt of theſe, that we ſhall mention, ſhall be an experiment, that we remember our ſelves formerly to have made upon frogs. For having opened one of them alive, and carefully cut out his heart, without cloſing up the orifice of the wound (which we had made wider than was neceſſary) the frog notwithſtanding leaped up and down the room as before, dragging his entrails (that hung out) after him; and, when he reſted, would upon a puncture leap again, and being put into the water, would ſwim, whilſt I felt his heart beating betwixt my fingers. The hearts of others of them were taken out at an inciſion, no greater than was requiſite for that purpoſe: when we had ſtitched or pinned up the wound, we obſerved them to leap more frequently and vigorouſly than the former: they would, as before they were hurt, cloſe and open their eye-lids upon occaſion. Being put into a veſſel not full of water, they would as orderly diſplay their fore and hinder legs in the manner requiſite to ſwimming, as if they wanted none of their parts, eſpecially not their hearts; they would reſt themſelves, ſometimes upon the ſurface of the

Divers motions and actions of frogs after their hearts were cut out.

the water, ſometimes at the bottom of it; and ſometimes alſo they would nimbly leap, firſt out of the veſſel, and then about the room, ſurviving the exſection of their hearts, ſome about an hour, and ſome longer. And that, which was further remarkable in this experiment, was, that we could, by gently preſſing their breaſt and belly with our fingers, make them, almoſt at pleaſure, make ſuch a noiſe, as to the by-ſtanders made them ſeem to croak. But how this experiment will be reconciled to the doctrine aſcribed to Mr. *Hobbes*, or to that of the Ariſtotelians, who tell us, that their maſter taught the heart to be the ſeat of ſenſe (whence alſo, though erroneouſly, he made it the original of the nerves) let thoſe, that are pleaſed to concern themſelves to maintain all his opinions, conſider.

Obſervations of the motion of a chicken's heart, after the head and other parts were cut off.

AND whereas frogs, though they can move thus long without the heart, yet they cannot at all bear the exemption or ſpoiling of the brain; we will add what we have obſerved, even in hot animals, whoſe life is conceived to be much more ſuddenly diſſipable, and the motion of each part much more dependent upon the influence of the brain: we opened then an egg, wherein the chick was not only perfectly formed, but well furniſhed with feathers; and having taken him out of the membrane, that involved him, and the liquors he ſwam in, and laid him on his back on a flat piece of glaſs, we clipped away, with a pair of ſciſſors, the head and the breaſt-bone; whereby the heart became expoſed to view, but remained faſtened to the headleſs trunk: and the chick lying in this poſture, the heart continued to beat above a full hour, and the ears ſeemed to retain their motion a pretty while after the heart it ſelf had loſt his; the motion of none of the other parts appearing many moments to ſurvive the loſs of the head: and, which is moſt conſiderable, the ſeemingly dead heart was divers times excited to new, though quickly ceaſing motion, upon the puncture of a pin, or the point of a pen-knife. And to evince, that this was no caſual thing, the next day we dealt with the chick of another egg, taken from the ſame hen, after the above-recited manner; and when the motion of the heart and ears began to ceaſe, we excited it again, by placing the glaſs over the warm ſteam of a veſſel full of hot water, bringing ſtill new water from off the fire to continue the heat, when we perceived the former water to begin to cool, and by this means we kept the heart beating for an hour and an half by meaſure. And at another time for further ſatisfaction, we did, by theſe and ſome other little induſtries, keep the heart of a ſomewhat elder chick, though expoſed to the open air, in motion, after we had carefully clipped off the head and neck, for the ſpace of (if our memory do not much miſ-inform us) two hours and an half by meaſure. Upon what conjectures we expected ſo laſting a motion in the heart of a chick, after it had loſt the head, and conſequently the brain, would be more tedious and leſs fit to be mentioned in this place, than the ſtrange vivacity we have ſometimes, not without wonder, obſerved in vipers: ſince not only their hearts clearly ſever'd from their bodies may be obſerved to beat for ſome hours (for that is common with them to divers other cold animals) but the body it ſelf may be, ſometimes, two or three days after the ſkin, heart, head, and all the entrails are ſeparated from it, ſeen to move in a twining or wriggling manner: nay (what is much more) may appear to be manifeſtly ſenſible of punctures, being put into a freſh and vivid motion, when it lay ſtill before, upon the being pricked, eſpecially on the ſpine or marrow, with a pin or needle.

Of the vivacity of diſſected vipers.

AND though tortoiſes be in the *Indies* many of them very large animals, yet that great traveller *Vincent le Blanc*, in his *French Voyages*, giving a very particular account of thoſe tortoiſes, which the Eaſt-Indian king of *Pegu*, (who was much delighted with them) did, with great curioſity, cheriſh in his ponds, adds this memorable paſſage as an eye-witneſs of what he relates: *When the king hath a mind to eat of them, they cut off their heads, and five days after they are prepared; and yet after thoſe five days they are alive, as we have often experienced.* Now although I will not ſay, that theſe experiments prove, that either it is in the membrane, that ſenſation reſides (though I have ſometimes doubted, whether the nerves themſelves be not ſo ſenſible, chiefly as they are inveſted with membranes) or that the brain may not be confined to the head, but may reach into the reſt of the body, after another manner than is wont to be taught; yet it may be ſafely affirmed, that ſuch experiments as theſe may be of great concernment in reference to the common doctrine of the neceſſity of unceaſing influence from the brain, being ſo requiſite to ſenſe and motion; eſpecially if to the lately mentioned particulars we add, on this occaſion, what we have obſerved of the butterflies, into which ſilk-worms have been metamorphoſed; namely, that they may, not only, like common flies, and divers other winged inſects, ſurvive a pretty while the loſs of their heads, but may ſometimes be capable of procreation after having loſt them: as I not long ſince tried (though not, perhaps, without ſuch a reluctancy as *Ariſtotle* would have blamed in a naturaliſt) by cutting off the heads of ſuch butterflies of either ſex. *Quamvis enim mas, cui prius amputatum eſt caput, nequaquam adduci poſſet (quæcunque inſecti illius eſt ſalacitas) ut fœminam comprimeret, decollata tamen fœmina marem alacriter admiſit. Et licèt poſt horas aliquot cœitu inſumptas ita requierit immota, ut mortuam per multas horas cogitarem, non ſolùm quia omnem penitus motum perdiderat, & in thorace ſatis magnum apparebat foramen, quod à parte aliqua corporis ſimul cum capite à trunco diſruptâ factum videbatur; verum etiam quoniam eodem permanſit ſtatu, idque per plures horas, ultra tempus, quo poſt coitionem cum mare hujus generis animalcula ſolent ordiri prolificationem. Tandem verò poſtquam jam diu de vita ejus deſperatum eſſet, ova fœtare tam confertim cœpit, ut vel exiguo temporis intervallo eorum plura in manu mea deponeret. An verò prolifica ſint futura, nondum comperi.*

And tortoiſes.

Whether there be a neceſſity of the unceaſing influence of the brain to ſenſe and motion.

That the ſilk-worm butterfly is capable of procreation after the loſs of its head.

THEIR opinion, that aſcribe the redneſs of the blood to the colour of the liver, through which it paſſes, is not diſcountenanced by the livers of men: but in hen-eggs, about the third or fourth day after incubation (for we have found the circumſtances of time much to vary) you may obſerve the *punctum ſaliens*, or heart, to be ever and anon full of conſpicuouſly red blood, before the naked eyes can ſo much as diſcern a liver, at leaſt before they can diſcover in it any redneſs; a yellowneſs being all I could obſerve in the parenchyma of the livers of divers chickens perfectly formed, and furniſhed with feathers, though not great enough to make their way out of the ſhell. And in divers great fiſhes I have found the veſſels of the liver full of very red blood, though the parenchyma or ſubſtance of it were white, or at leaſt did not at all participate, much leſs impart a ſanguine colour.

That the redneſs of the blood is not to be aſcribed to the liver, proved by the inſpection of the liver of chickens unhatched.

THE doctrine ſo unanimouſly delivered by phyſicians and chirurgeons, concerning the irreparable loſs of the limb of an animal, once violently ſever'd from the body, will appear unfit to be admitted, whithout ſome reſtriction, by what may be experienced in lizards, in lobſters, and craw-fiſhes, and perhaps in ſome other living creatures. For of lizards it hath been often obſerved in hot countries, and even in *France*, that their tails being ſtruck off will grow again. And the like hath been of old obſerved by *Pliny*; and the experienced *Bontius* delivers it upon his own knowledge in theſe words: *Hoc in domeſticis meis non ſemel animadverti, dum filioli mei luſitabundi bacillo caudas iis decutiebant, quas tamen poſt diem unum aut alterum ad ſolitum pabulum revertentes vidi, caudaſque iis paulatim reaccreſcere:* 'This I 'have more than once obſerved in lizards, 'which I kept in my own houſe. For my 'children being at play, when with a rod 'they had ſtruck off the lizards tails, I ſaw 'them within a day or two come out to feed, 'and their tails then by little and little ſtill in-'creaſing and growing bigger.'

That the loſs of a limb in all animals is not irreparable.

THAT the claws likewiſe of lobſters being torn off, another will ſometimes grow in the room of it, is not only ſaid by fiſhermen, but hath been affirmed to me by very credible perſons, one of which aſſured me, that he himſelf had obſerved it very often. And I am the more apt to believe it, becauſe the like is to be met with among craw-fiſhes, which are ſo like lobſters, that by many they are taken (though not conſiderately enough) to be but a ſmaller kind of them. For I remember, that going to look upon a repoſitory, where a multitude of them was kept, and cauſing divers of the faireſt to be thrown up, that I might take the ſtony concretions, commonly called *oculi cancrorum*, out of their heads, I obſerved one large fiſh, that had one of his claws proportionable to the bulk of his body, but the other ſo ſhort and little, that the greater ſeemed to be four or five times as big as it; whereupon its good ſhape and freſh colour ſeeming to argue it to be but young and growing, invited me to aſk one of them, that had the overſight of the fiſh, whether he had formerly ſeen any claws torn off grow again, he affirmed to me, that in that ſort of fiſh it was very uſual.

I COULD alſo tell you, how fruitleſly I have endeavoured to diſcover that ſtomachical acidity, to which many of our modern phyſicians are pleaſed to aſcribe the firſt digeſtion of the nutriment of animals, in the purpoſely diſſected ſtomachs of ravenous ſea-fiſhes; in whoſe ſtomachs, though our taſte could not perceive any ſenſible acidity, yet we found in one of them a couple of fiſhes, each of them about a foot long: whereof the one, which ſeemed to have been but newly devoured, had ſuffered little or no alteration in the great fiſh's ſtomach; but the other had all its outſide, ſave the head, uniformly waſted to a pretty depth, beneath the former ſurface of the body, and looked as if it had been not boiled, or wrought upon by any conſiderable heat, but uniformly corroded, like a piece of ſilver coin kept a while in aqua fortis, according to the criminal tricks of adulterators of money.

That notwithſtanding the great ſolution and digeſtion of meat in the ſtomachs of fiſhes, no ſenſible acidity is found there.

YET I am loth, till I have perfected what I deſign in order to that inquiry, either to embrace or reject the opinion I find ſo general among the moderns, concerning the ſolution of meat in the ſtomach by ſomething of acid. And I remember, that when I was conſidering what might be alledged for, as well as againſt that opinion, I deviſed this experiment, among others, in favour of it. I provided a liquor, with which I drenched a piece of a wing of a pullet, having firſt well cruſhed it between my fingers, to make ſome amends for the omiſſion of chewing it; and having a little incorporated the liquor and the muſculous fleſh, they immediately changed colour, and in about an hour grew to be a kind of gelly, in colour and conſiſtence not unlike quince marmalade. This mixture, by the next morning, did, as I expected, turn to a deep blood-red, or ſometimes rather a lovely purple liquor, though all this while there had been no external heat imployed to promote the action of the menſtruum. And the like experiment I tryed alſo with a piece of mutton, with bread, and a piece of veal, and other edible things, which at that time occurred to me; and found the operation of the liquor almoſt uniform, though it ſeemed to act moſt effectually upon fleſh. And to gratify in ſome meaſure your curioſity, *Pyrophilus*, I am content to tell you, that the menſtruum was drawn from vitriol, and that with the bare oil of it I have (though I could not with aqua fortis) performed no leſs than what I have yet mentioned: but leſt this ſhould be thought a digreſſion, let it ſuffice to have, on this occaſion, mentioned thus much upon the by.

Experiments concerning the ſolution of meats, and their change of colours by acid menſtruums.

To what we lately took notice of concerning the heart may be added, that on the ſea-coaſt *Ireland*, I obſerved a ſort of fiſhes about the bigneſs of mackrels, whoſe hearts were of an inverted figure, compared to thoſe of other animals; the baſis or broad end of the heart being neareſt the tail, and the acuminated part or apex being coherent to the great artery, and reſpecting the head.

To

To all theſe triſling obſervations divers more conſiderable ones might be added, but they may be more ſeaſonably inſiſted on elſewhere; and thoſe already mentioned may ſuffice to let you ſee, that the naturaliſt his zootomy may be very ſerviceable to the phyſician in his anatomical inquiries.

NOR is it only by the diſſection of various animals, that the naturaliſt may promote the anatomiſt's knowledge, but perhaps alſo he may do it by deviſing ways to make the dead bodies of men, and other animals, keep longer than naturally they would do. For ſince experience teaches us, that men find it very eaſy to forget the originations, windings, branchings, inſertions, and other circumſtances of particular veſſels, and other parts of the body, as well as thoſe, that ſtudy botanicks, are wont to complain of their eaſy forgetting the ſhapes, differences, and alterations of ſmaller plants; it cannot but be a great help to the ſtudent of anatomy to be able to preſerve the parts of human bodies, and thoſe of other animals, eſpecially ſuch monſters, as are of a very ſingular or inſtructive fabrick, ſo long, that he may have recourſe to them at pleaſure, and contemplate each of them ſo often and ſo conſiderately, till he have taken ſufficient notice of the ſhape, ſituation, connection, *&c.* of the veſſel, bone, or other part, and firmly impreſſed an idea of it upon his memory. We find our ſelves much helped to retain in our memory the figures and differences of vegetables, by thoſe books, which ſome curious botaniſts make, wherein the plants themſelves, artificially dried, are diſplayed upon, and faſtened to leaves of white paper. If it were not for one of thoſe books, wherein I have in one vaſt volume almoſt all the plants of one of the chief phyſick-gardens in *Europe*, I ſhould every year forget, by the end of winter, to know again moſt of the ſmaller plants I had learned to take notice of in the ſpring. And by the way it is obſervable, how long plants, by being carefully indeed, but barely dried in the ſhade betwixt ſheets of paper, which help to ſoak up the ſuperfluous moiſture, may be preſerved. For I have divers years had an herbal, wherein ſeveral of the flowers, and other plants, retain their native yellow and blue, *&c.* (but ſomewhat faint) though by the date it appeared to be 22 or 23 years old. And I am apt to think, that it would be very poſſible for anatomiſts alſo to preſerve the bodies they contemplate for a conſiderable time: for experience hath informed us in good number of ſuch animals, that butterflies, and divers other flying inſects, may have their ſhape and colours preſerved, I know not how long, by running them through in ſome convenient part with pins, and therewith ſticking them to the inſide of large boxes. And on this occaſion, I remember, that having ſometimes reflected upon the laſting of ſpiders, flies, and other ſmall living creatures, that having been caſually encloſed in amber whilſt it was ſoft, are ever preſerved entire and uncorrupted, I thought it not amiſs to try, whether ſome ſubſtance, like amber (at leaſt as to the newly mentioned uſe of it) might not eaſily be prepared by art. And hereupon I quickly found, that by taking good clear *Venice* turpentine, and gently evaporating away about a third part of it, (ſometimes more, ſometimes leſs, according to the exigency of my particular purpoſe;) I could make a reddiſh gum, diaphanous and without bubbles, which would melt with a very gentle heat, and eaſily (being ſuffered to cool) become again ſo hard as to be brittle. This reſinous ſubſtance ſhould be melted with as little heat as is poſſible, (and therefore ſhould be firſt powdered) that the texture of the vegetable or animal bodies to be caſed over with it, might receive the leſs alteration: and when it is brought to the requiſite degree of fluidity, then the body to be preſerved (being, if that be needful, ſtruck through with a pin) muſt be gently plunged into it, and preſently taken out and ſuffered leiſurely to cool, being turned from time to time this way or that way, if there be occaſion, that the inveſting matter may be every where of an equal thickneſs upon it. And if at the firſt time the caſe be not thick enough, it may again, when it is cold, be immerſed into the liquid matter, (as chandlers are wont to thicken their candles, by dipping them frequently into melted tallow) of which ſome will every way adhere to it. And though theſe caſes be inferiour to amber, in regard of their being more apt to be ſullied by duſt, or otherwiſe; yet that inconvenience may be eaſily remedied, by keeping them ſhut up in glaſſes or boxes, at thoſe times, when one hath not occaſion to conſider them. And their clearneſs (eſpecially if they be thin) and their ſmooth ſurfaces, together with their exactly keeping out the air from the body they encloſe, may, perhaps, make ſo cheap and ſo eaſy an experiment a not unwelcome trifle, eſpecially conſidering, how eaſily it is capable of improvement.

Ways of artificial drying and preſervation of plants.

And inſects.

BUT to return to the preſervation of more bulky bodies, it is a known thing to the collectors of rarities, that the external idea of fiſhes, crocodiles, birds, and even horſes, may be preſerved for many years, by taking out the more corruptible parts, and ſtuffing their prepared ſkins with any convenient matter. And that the internal membranous parts of bodies may be long and eaſily kept from putrefaction, is not unknown to many anatomiſts. And not to mention what we have tried of this ſort, we have ſeen the veins, arteries, and nerves of a human body, laid out in their natural ſituation upon three boards, by the pains and ſkill of an accurate anatomiſt of *Padua*. And elſewhere, *Uterum vidimus atque omnia mulieris genitalia*, together with the bladder, all diſplayed upon a board, preſerved for many years ſo entire, and in a ſituation ſo near the natural, that this ſcheme was far more inſtructive, than the moſt accurate printed one could poſſibly be. We have likewiſe known the fleſh of vipers, kept not only ſweet but efficacious, for divers years, by the ſmoke of a peculiar powder, chiefly conſiſting of aromatick ingredients, and of which you, *Pyrophilus*, may command the compoſition.

And more bulky bodies.

Particularly the ſchemes of divers parts of human body.

We have also seen the skeleton of a monkey, made by an excellent French chirurgeon of our acquaintance, whereon the tendons and fibres of the muscles were so preserved, that it was looked upon as a rarity, very useful to shew their originations and insertions, and to explain the motions of the limbs: and perhaps there may be some way to keep the arteries and the veins too, when they are emptied of blood, plump, and unapt to shrink overmuch, by filling them betimes with some such substance, as, though fluid enough when it is injected to run into the branches of the vessels, will afterwards quickly grow hard. Such may be the liquid plaister of burnt alabaster, formerly mentioned, or ising-glass steeped two days in water, and then boiled up, till a drop of it in the cold will readily turn into a still gelly. Or else *saccharum Saturni*, which, if it be dissolved often enough in spirit of vinegar, and the liquor be each time drawn off again, we have observed to be apt to melt with the least heat, and afterwards to grow quickly into a somewhat brittle consistence again. But I must not insist on these fancies, but rather add, that I have known an embryo, wherein the parts have been very perfectly delineated and distinguishable, preserved unputrified for several years; and I think it still continues so, by being seasonably and artificially embalmed with oil (if I much misremember not) of spike. And I have elsewhere seen a large embryo, which after having been preserved many years, by means of another liquor (whose composition I do as yet but guess at) did, when I saw it, appear with such an admirable entireness, plumpness, and freshness, as if it were but newly dead: and that which concurs to make me hope, that some nobler way may be yet found out, for the preservation of dead bodies, is, that I am not convinced, that nothing can powerfully resist putrefaction in such bodies, but things, that are either saline and corrosive, or else hot; nor that the embalming substances cannot be effectually applied, without ripping open the body to be preserved by them. For *Josephus Acosta*, a sober writer, relates, that in certain American mountains, men, and the beasts they ride on, sometimes are killed with the winds, which yet preserve them from putrefaction, without any other help. So insensible a quantity of matter, such as it may be, may, without incision made into the body, both pervade it, and as it were embalm it. I know also a very experienced and sober gentleman, who is much talked of, for curing of cancers in womens breasts, by the outward application of an indolent powder, some of which he also gave me, but I have not yet had the opportunity to make trial of it. And I shall anon tell you, that I have seen a liquor, which, without being at all either acid or caustick, is in some bodies far more effectual against putrefaction, than any of the corrosive spirits of nitre, vitriol, salt, &c. and than any of the other saline liquors, that are yet in use. We have also tried a way of preserving flesh with musk, whose effects seemed not despicable to us, but must not here be insisted on.

Of the preservation of an embryo divers years, by embalming it with oil of spike.

Instances of men in the American mountains killed, and afterwards preserved from putrefaction, only by the wind.

Nor were it amiss, that diligent trial were made, what use might be made of spirit of wine, for the preservation of a human body. For this liquor being very limpid, and not greasy, leaves a clear prospect of the bodies immersed in it; and though it do not fret them, as brine, and other sharp things, commonly imployed to preserve flesh, are wont to do; yet it hath a notable balsamick faculty, and powerfully resists putrefaction, not only in living bodies (in which, though but outwardly applied, it hath been found of late one of the potentest remedies against gangrenes) but also in dead ones. And I remember, that I have sometimes preserved in it some very soft parts of a body for many months (and perhaps I might had done it for divers years, had I had opportunity) without finding, that the consistence or shape was lost, much less, that they were either putrified or dried up: we have also, by mixing with it spirit of wine, very long preserved a good quantity of blood, so sweet and fluid, that it was wondered at by those, that saw the experiment. Nay, we have for curiosity sake, with this spirit, preserved from further stinking a portion of fish, so stale, that it shined very vividly in the dark; in which experiment, we also aimed at discovering, whether this resplendent quality of the decaying fish would be either cherished or impaired by the spirit of wine, (whose operations in this trial, we elsewhere inform you of) and it would be no very difficult matter for us to improve, by some easy way, this balsamical virtue of spirit of wine, in case you shall think it worth while. But not to anticipate what I may more properly mention to you elsewhere, I shall at present say no more touching the conservation of bodies, since probably by all these, and some other particulars, we may be induced to hope so well of human industry, as not to despair, that in time some such way of preserving the bodies of men, and other animals, will be found out, as may very much facilitate and advance too, anatomical knowledge. Neither is it only by advancing this, that the naturalist may promote the physiological part of physick: for since the body consists not only of firm and constant parts, as the bones, muscles, heart, liver, &c. but of fluid ones, as the blood, serum, gall, and other juices; and since consequently to the complete knowledge of the use of all the parts, we should investigate not only the structure of the solid ones, but the nature of the fluid ones; the naturalist may do much more than hath yet been done, towards the perfecting of this knowledge, not only by better explicating what it is in general, makes bodies either consistent or fluid, but by examining particularly, and especially in a pyrotechnical way, the nature of the several juices of the body, and by illustrating the alterations, that those juices, and the aliments they are made of, receive in the stomach, heart, liver, kidneys, and other viscera. For although a human body, being the most admirable corporeal piece of workmanship of the omniscient Architect, it is scarce to be hoped, but that even among the things, that happen ordinarily and regularly in it, there will be

Of the use of spirit of wine, for the preservation of bodies from putrefaction.

That the examination of the juices of human body, by the art of chirurgery, may illustrate their use and nature.

be many, which we ſhall ſcarce be able to reach with our underſtanding, much leſs to imitate with our hands: yet peradventure, if chymical experiments, and mechanical contrivances, were induſtriouſly and judiciouſly aſſociated by a naturaliſt profoundly ſkilled in both, and would make it his buſineſs to explain the phænomena of a human body, not only many more of them, than at firſt one would think, might be made more intelligible than as yet they have been; but divers of them (eſpecially thoſe relating to the motions of the limbs and blood) might be by artificial engines (conſiſting as the pattern not only of ſolid, but liquid and ſpirituous parts) not ill repreſented to our very ſenſes: ſince a human body it ſelf ſeems to be but an engine, wherein almoſt, if not more than almoſt, all the actions common to men with other animals are performed mechanically. But of the difference of theſe living engines from others, I may elſewhere have a fitter opportunity to diſcourſe to you. For at preſent, *Pyrophilus*, I have employed ſo much of the little time my occaſions will allow me to ſpend upon the treatiſe I am now writing, in making out to you the uſefulneſs of natural philoſophy to the phyſiological part of phyſick, that I muſt not only not proſecute this ſubject, but muſt both haſten to mention, and to mention the more curſorily its ſerviceableneſs to the four remaining parts of the phyſician's art.

That the actions, which are common to men, with other animals, being performed mechanically, the skill of mechanicks muſt be of uſe to phyſiology.

ESSAY II.

Offering ſome Particulars relating to the Pathological part of Phyſick.

That the naturaliſts knowledge may aſſiſt the phyſician to diſcover the nature and cauſes of diſeaſes.

AND to ſay ſomething in the next place of pathology, that the naturaliſt's knowledge may aſſiſt the phyſician to diſcover the nature and cauſes of ſeveral diſeaſes, may appear by the light of this conſideration, that though divers Paracelſians (taught, as they tell us, by their maſter) do but erroneouſly ſuppoſe, that man is ſo properly a microcoſm, that of all the ſorts of creatures, whereof the macrocoſm or univerſe is made up, he really conſiſts; yet certain is it, that there are many productions, operations, and changes of things, which being as well to be met with in the great, as in the little world, and divers of them diſcloſing their natures more diſcernibly in the former, than in the latter; the knowledge of the nature of thoſe things, as they are diſcoverable out of man's body, may well be ſuppoſed capable of illuſtrating many things in man's body, which receiving ſome modifications there from the nature of the ſubject they belong to, paſs under the notion of the cauſes or the ſymptoms of diſeaſes. If I were now, *Pyrophilus*, to diſcourſe to you at large of this ſubject, I think I could convince you of the truth of what I have propoſed. And certainly, unleſs a phyſician be (which yet I fear every one is not) ſo much a naturaliſt, as to know, how heat and cold, and fluidity, and compactneſs, and fermentation, and putrefaction, and viſcoſity, and coagulation, and diſſolution, and ſuch like qualities, are generated and deſtroyed in the generality of bodies, he will be often very much to ſeek, when he is to inveſtigate the cauſes of preternatural accidents in men's bodies; whereof a great many depend upon the preſence, or change, or vaniſhing of ſome or other of the enumerated qualities, in ſome of the fluid or ſolid ſubſtances that conſtitute the body. And that the explications of a ſkilful naturaliſt may add much to what has hitherto commonly been taught concerning the nature and origin of thoſe qualities in phyſicians ſchools, a little comparing of the vulgar doctrine with thoſe various phænomena, to be met with among natural things, that ought to be, and yet ſeem not to be, explicable by it, will eaſily manifeſt to you. And queſtionleſs it is a great advantage to have been taught, by variety of experiments in other bodies, the differing ways, whereby nature ſometimes produces the ſame effects. For ſince we know very little *à priori*, the obſervation of many ſuch effects, manifeſting, that nature doth actually produce them ſo and ſo, ſuggeſts to us ſeveral ways of explicating the ſame phænomenon, ſome of which we ſhould perhaps never elſe have dreamed of. Which ought to be eſteemed no ſmall advantage to the phyſician; ſince he, that knows but one or few of nature's ways of working, and conſequently is likely to ignore divers of thoſe, whereby the propos'd diſeaſe (or ſymptom of it) may be produc'd, muſt ſometimes conclude, that preciſely ſuch or ſuch a thing is the determinate cauſe of it, and apply his method of relieving his patient accordingly; which often proves very prejudicial to the poor patient, who dearly pays for his phyſician's not knowing, that the quality, that occaſions the diſtemper, may be as probably, if not more rationally, deduced from another origin, than from that, which is preſumed. This will ſcarce be doubted by him, that knows how much more likely explications than thoſe applauded ſome ages ſince, of divers things, that happen as well within as without the body, have been given by later naturaliſts, both philoſophers and phyſicians: and how much the theory of the ſtone, and many other diſeaſes, that has been given us by thoſe many phyſicians, that would needs deduce all the phænomena of diſeaſes from

Proved by general reaſon.

from heat, cold, and other elementary qualities, is inferiour to the account given us of them by thoſe ingenious moderns, that have applied to the advancement of pathology, the circulation of the blood, the motion of the chyle by the milky veſſels to the heart, the conſideration of the effects deducible from the pores of greater bodies, and the motion and figuration of the minute parts, together with ſome of the more known chymical experiments: though both of thoſe, and of the other helps mentioned juſt before them, I fear men have hitherto been far enough from making the beſt uſe, which I hope it will daily more and more appear they are capable of being put to. He that has not had the curioſity to inquire out, and conſider the ways, whereby ſtones may be generated out of the body, not only muſt be unable ſatisfactorily to explicate how they come to be produced in the kidneys and in the bladder, but will, perhaps, ſcarce keep himſelf from embracing ſuch errors, becauſe authorized by the ſuffrage of eminent phyſicians, as the knowledge I am reccommending would eaſily protect them from. For we find divers famous, and, otherwiſe, learned doctors, who (probably becauſe they had not taken notice of any other way of hardening a matter, once ſoft, into a ſtone-like conſiſtence) have believed and taught that the ſtone of the kidneys is produced there by ſlime baked by the heat and dryneſs of the part; as a portion of ſoft clay may, by external heat, be turned into a brick or tile. And accordingly they have, for cure, thought it ſufficient to make uſe of ſtore of remedies to moiſten and cool the kidneys; which, though in ſome bodies this be very convenient, are yet far inferiour in efficacy to thoſe nobler medicines, that by ſpecifick qualities and properties are averſe to ſuch coagulations as produce the ſtone. But (not to mention what a phyſician ſkilled in anatomy would object againſt this theory from the nature of the part affected) it is not unlike, the embracers of this hypotheſis would not have acquieſced in it, if they had ſeen thoſe putrefactions out of the bodies of men, which we elſewhere mentioned. For thoſe would have informed them, that a liquor abounding with petreſcent parts may not only turn wood (as I have obſerved in a petrifying ſpring) into a kind of ſtone, and may give to cheeſe and moſs, without ſpoiling their priſtine appearance, a ſtrong hardneſs and weight; but may alſo produce large and finely ſhaped cryſtalline bodies (though thoſe I tried were much leſs hard than cryſtal) in the boſom of the cold water. Which brings into my mind, that I have divers times produced a body of an almoſt ſtony hardneſs in leſs than half an hour, even in the midſt of the water, by tying up in a rag, about the quantity of a nutmeg of well and recently calcined alabaſter, which being thus tied up and thrown into the bottom of a baſon full of water, did there ſpeedily harden into lapideous concretion. And that even in the bodies of animals themſelves, ſuch concretions may be generated much otherwiſe, than the hypotheſis we have been ſpeaking of ſuppoſes, may appear by what happens to craw-fiſhes, which though cold animals, and living in the waters, have generated at certain ſeaſons in their heads, concretions, which for their hard and pulverizable conſiſtence, divers authors called *lapides cancrorum*, though in the ſhops they are often, but abuſively ſtyled *oculi cancrorum*. And ſuch ſtrong concretions are affirmed to be generated in theſe fiſhes every year, which I the leſs ſcrupled at, becauſe I have not found them at all times in the head of the fiſh. And beſides theſe and many more concretions, that had they been obſerved by the phyſicians we have been ſpeaking of, might eaſily have kept them from acquieſcing in, and maintaining their improbable explication of the manner of the ſtone's nativity; there is yet another kind of coagulation, which may both be added to the former, and perhaps alſo may ſerve to recommend the uſe of chymical experiments, inveſtigating the cauſes of diſeaſes. This is made by the mixture of exquiſitely dephlegmed ſpirit of fermented human urine, with as exactly rectified ſpirit of wine: for upon the confuſion of thoſe two volatile liquors in a juſt proportion, they will both of them, as after *Lullius*, experience hath informed us, ſuddenly coagulate into a white maſs, which *Helmont* calls *Offa Alba*, and by which he endeavours to declare the procreation of the *Duelech*. For ſuppoſing himſelf to have found in human urine a potential *aqua vitæ*, or vinous ſpirit, capable of being excited by a putrid ferment, and coagulable by the volatile ſalt of the ſame urine, if there were any volatile earth lurking in the liquors; that being apprehended by the uniting ſpirits, and coagulated with them both, he ſuppoſeth there may emerge from the union of thoſe three bodies, ſuch an anomalous concretion, as he, after *Paracelſus*, calls *Duelech*.

By particular inſtances of the cauſe of the ſtone in the kidneys.

The cauſe of that diſeaſe illuſtrated by the putrefaction of wood, cheeſe, moſs, water, &c.

The origin of Helmont's Alba Offa, *and* Paracelſus's Duelech, *by the mixture of ſpirit of wine and ſpirit of urine, an example of the generation of the ſtone.* Helmont. *de Lith.* cap. 3 & 4.

AND that a ſubtile terreſtrious ſubſtance may lurk undiſcerned, even in limpid liquors, may appear not only in wine, which rejects and faſtens to the ſides of the containing veſſel, a tartar, abounding in terreſtrious feculency; and in common urine of healthy men, which, though clear, at its firſt emiſſion into the urinal, does, after a little reſt there, let fall an hypoſtaſis, or ſediment, which, if diſtilled before fermentation, leaves in the bottom of the cucurbit an earthy ſubſtance, and commonly ſome gravel: but even in rectified ſpirit of urine it ſelf I have had opportunity to obſerve, that after very long keeping, there hath ſpontaneouſly precipitated a feculency, copious enough in proportion to the liquor, that afforded it. Nay, in another parcel of ſpirit of urine, that hath been kept much longer than that already mentioned, we obſerved the other day, that not only there was a terreſtrial reſidence fallen to the bottom of the glaſs; but to the ſides of it, as far as the liquor reached, there adhered a great multitude of ſmall concretions; which, as far as appeared by looking on them through the cryſtal phial, to whoſe inſides they are faſtened, were no other than little grians of gravel, ſuch as are often found ſticking to the inſides of urinals, employed by calculous perſons.

That a terreſtrious ſubſtance may lurk undiſcerned in limpid liquors.

To which we might add an experiment of ours, whereby we are wont almoſt in a moment, by barely mixing together a couple of liquors, both of them diſtilled and tranſparent, and yet not both of them ſaline, to thick them very notably and permanently, inſomuch that they ſeem not to precipitate each other; yet having once, for curioſity-ſake, diſtilled them with a pretty ſtrong fire, I obtained a great quantity (as I remember, a fourth of the whole mixture) of a blackiſh maſs, that was not only coagulated and dry, but even brittle. But of the coagulation of diſtilled liquors, ſuch as even chymiſts themſelves are not wont to look upon as at all diſpoſed to coagulation, I may elſewhere have a better opportunity to entertain you, and therefore I ſhall forbear to do it now.

AND by this way, *Pyrophilus*, doth *Helmont*, if I underſtand him aright, attempt to make out the generation of the ſtone in human bodies: in which theory though ſome difficulties do yet keep me from acquieſcing, yet beſides that, perhaps what you will meet with by and by (about the diſtillation of the *Duelech*) may make you the leſs wonder at this explication; beſides this, I ſay, granting that none of the enumerated ways of petreſcency (if I may ſo ſpeak) deſerve to be looked upon as ſatisfactory; yet to give ſo much as an account not very abſurd, of a diſeaſe ſo anomalous and abſtruſe, and hitherto ſo unluckily explicated by phyſicians, is perhaps more difficult, than it were to give (at leaſt) a plauſible account of divers other diſtempers.

The uſe of chymiſtry in explaining the nature of, and aberrations in our digeſtions.

AND poſſibly it may be ſafely enough affirmed, that not only phyſiology, in its full extent, but that handmaid to it, which is called chymiſtry, may not a little contribute to clear up the nature of both of the digeſtions, and of thoſe deficiencies or aberrations in them, which produce a great part of diſeaſes; eſpecially if we allow what, as well phyſicians, as Spagyriſts agree in, (whether warily enough or not, I ſhall not now diſpute) *viz.* that whatever is ſeparable from bodies by the fire, was, as a conſtituent element (or principle,) preexiſtent in them.

PERHAPS I need not mind you, *Pyrophilus*, that it is uſual with the meerly Galenical doctors themſelves to explicate the nature of catarrhs, by comparing the ſtomach to a ſeething-pot, and the head to an alembick, where the aſcending vapours, being, by the coldneſs of the brain, condenſed into a liquor, ſometimes diſtil upon the lungs, and ſometimes fall upon other weakened parts: in which explication though for divers reaſons I cannot acquieſce, yet it may ſuffice to ſhew you, how little ſcruple many learned men, not like to be partial in the caſe, would make of employing chymical operations to illuſtrate the doctrine of diſeaſes. And indeed, ſince the liquors contained in the body abound, divers of them, with ſaline or ſulphureous parts, he, that hath been by chymiſtry taught the nature of the ſeveral ſorts of ſalts and ſulphurs, and both beheld and conſidered their various actions upon one another, and upon other bodies, ſeems to have a conſiderable help to diſcourſe groundedly of the changes and operations of the humours, and other juices contained in the body, which he hath not, that hath never had *Vulcan* for his inſtructor. He that finds, that there may be acid juices in the ſtomach, and elſewhere, (as is frequently evident in the ſharp liquors, which many ſtomachs caſt up) and that there are alſo ſulphureous ſalts in the body (as is apparent in blood and urine, which abounds with ſuch:) He that knows that the ſerum, that ſwims upon the blood out of the body, is by a gentle heat immediately coagulable into a thick whitiſh ſubſtance, not unlike a cuſtard; and that chymically analyzed blood yields ſtore of volatile ſulphureous, but (as far as our trials have hitherto informed us) no acid, ſaltneſs:

Proved by a catalogue of conſiderable obſervations.

HE that knows, that theſe animal ſalts and ſpirits may be ſo powerful, that we have been able with ſpirit of urine, or of hartſhorn, to make a red ſolution of flowers of ſulphur, and that with ſpirit of urine (though drawn without violence of fire) we have (as we elſewhere more particularly declare) diſſolved both in a very gentle heat, and in a very ſhort time, the unopened body of crude copper, ſo as to make thereof a ſolution of a rich, deep, and even opacous blue; and that we have done almoſt the like with unrectified ſpirit of man's blood:

HE that hath, as we have done, examined by fire (eſpecially produced by the help of a burning-glaſs) that limpid liquor, that is to be found in the limphatick veſſels, and hath taken notice of that odd conſiſtence, ſmell, crackling, and other qualities diſcernible in it by heat:

HE that obſerves, how acid liquors loſe their acidity, by working upon ſome bodies; as when ſpirit of vinegar grows almoſt inſipid upon the coral it hath corroded; and how thoſe ſaline liquors, by working upon certain bodies, degenerate into ſalts of another nature, as we have ſometimes obſerved in oil of vitriol, working upon the fourth part of its weight of quickſilver, and how the contrariety of acid and ſulphureous ſalts makes them ſometimes diſarm, ſometimes, after ſome ebullition, precipitate each other; and ſometimes unite into a third ſubſtance, of a differing nature from either of thoſe, from whoſe coalition it reſults, as we ſee in *tartarum vitriolatum*; and, as I have obſerved, in a ſalt, I ſometimes make to emerge from a due proportion of oil of vitriol and ſpirit of urine, freed, after conjunction, from their aqueous moiſture: And he, in a word, that hath carefully analyzed and made trials on many parts, both of the macrocoſm and microcoſm, and heedfully applied his experiments made on the former to the illuſtration of the changes obſervable in the latter, ſhall be likely to explicate divers particulars in pathology more intelligibly, than he that is a ſtranger to chymiſtry.

That ſalt and ſulphur have more influence in the cauſation of diſeaſes, than the firſt qualities are, heat, cold, &c.

AND though I am very unwilling to meddle with medical controverſies, and am apt to think, that chymiſts are wont to ſpeak ſomewhat too ſlightingly of the humours of the human body, and allow them too little a ſhare in the production of diſeaſes; yet (to ſkip other reaſons) the ſtrange ſtories related by

by *Skenkius*, and other eminent phyſicians, of the corroſiveneſs of ſome juices, which, rejected by urine or vomits, have been able to boil on braſs, fret linen, and ſtain ſilver; together with ſome odd obſervations of this nature our ſelves have had opportunity to make, do very much incline us to believe, that the generality of former phyſicians have aſcribed too much to the humours, under the notion of their being hot and dry, cold and moiſt, or endowed with ſuch other elementary qualities, and have taken a great deal too little notice of the ſaline (if I may ſo ſpeak) and ſulphureous properties of things. And in this opinion I am not a little confirmed by the authority of *Hippocrates* himſelf, both in other paſſages, and eſpecially where he ſays, *Non calidum, frigidum, humidum, aut ſiccum eſſe, quod magnam agendi vim habet, verum amarum & ſalſum, & dulce & acidum, & inſipidum & acerbum, &c.* are the things, which, though inoffenſive to the body, whilſt they duely allay each other, prove hurtful to it, and diſtemper it, when any of them comes to ſerve it ſelf from the reſt, and grow predominant. And indeed, if the juices of the body were more chymically examined, eſpecially by a naturaliſt, that knows the ways of making fixed bodies volatile, and volatile fixed, and knows the power of the open air in promoting the former of thoſe operations; it is not improbable, that both many things relating to the nature of the humours, and to the ways of ſweetening, acuating, and otherwiſe altering them, may be detected, and the importance of ſuch diſcoveries may be diſcern'd.

Obſervations made upon the liquor, that diſtends the abdomen in the dropſy.

AND perhaps it would add to the uſefulneſs of ſuch an examination, if it were extended to the noxious juices in diſtempered bodies: ſuch as the rotten phlegm ſpit up by thoſe whoſe lungs are diſaffected; the ſlimy excretions voided in the lientery, and the liquor, that diſtends the *abdomen* in the dropſy and *aſcites*: concerning which (to tell you that upon the by) I found, that it was of a differing nature from either water or urine. For a *Paracenteſis* being made in the *abdomen* of one dangerouſly ſick of this ſort of dropſy, I found, that the liquor would keep a pretty while without putrefaction, (nor did the patient's body, when I afterwards ſaw it opened, ſmell almoſt at all, though the inſide of the *abdomen* look'd well as near as black, as if it had been ſphacelated:) and having ſteamed away ſome of it, whilſt it was pretty freſh, over a ſomewhat ſlow fire, it firſt coagulated into a ſubſtance like whites of eggs, and, by a little farther evaporation, turned to ſuch a glutinous ſubſtance, as tradeſmen are wont to call ſize; and being kept longer on the fire grew to be hard like fiſh-glew, but more brittle, and tranſparent enough, but with a little tincture of a greeniſh yellow; and ſome of the foremention'd liquor being diſtilled in a retort, did towards the end of the operation ſo darken the veſſel with a thick blackiſh oil, as hindered me from diſcerning what elſe perhaps I might have ſeen. And I ſuppoſe it may prove a uſeful inſtance to the former purpoſe, if I ſomewhat circumſtantially annex here what occurred to me, when I was accidentally conſidering of the *calculus humanus*.

Paracenteſis.

Obſervations on the calculus humanus.

HAVING therefore obtained of a ſkilful lithotomiſt of my acquaintance divers ſtones, which he had cut out of men's bladders, I choſe a couple of them (which were whitiſh almoſt, of equal bigneſs, and figure, which was near oval, and which together weighed about two ounces and an half:) theſe with the help of a ſtrong knife I carefully opened, to find whether or no either of them conſiſted of an intire and uniform matter, (as moſt other ſtones; and even ſome *calculi humani* do;) and I found, that each of them was made up of ſeveral ſhells, as it were ſucceſſively involving one another, like the rinds of an onion. And ſuch ſhells, but more ſoft, and more of a colour, we likewiſe obſerved in a great ſtone taken a while ſince out of an ox's gall, and ſent us for a preſent: and though all of theſe were of an almoſt ſtony hardneſs, yet that hardneſs was not equal in them all; and in one of the ſtones we obſerved one of the rinds (to make uſe of that expreſſion) to be of a differing colour both from that which immediately embraced it, and from that which it immediately embraced: ſome of theſe rinds equalled in thickneſs the length of a barley-corn, and others were ſomewhat thinner. Though they did cloſely embrace one another, yet they were actually ſeparable, as well as viſibly diſtinguiſhable. And proceeding very warily in the breaking one of theſe ſtones, we found, that in the center of it there lay a ſmall and ſoft oval ſtone, as it were the kernel of thoſe conglomerated ſhells; and this kernel lay ſo looſe, that with a little induſtry and patience we picked it out of the ſhell, and kept it by us as a rarity. This done, being deſirous to know, whether chymical tortures would force theſe concretes to a farther confeſſion of their nature, we cauſed them to be finely powdered, and put into a ſmall but ſtrongly coated glaſs-retort, whereunto luting a much larger retort for a receiver, we found, that theſe two ounces and half of powder, being diſtilled for ſome hours in a naked fire, afforded us great ſtore of volatile ſalt (partly grey and partly white) which almoſt covered the inſide of the receiver, and a pretty quantity of reddiſh ſpirit, which in the receiver itſelf ſoon coagulated into ſalt: and having ſever'd our veſſels, we found in the neck of the receiver a very little darkiſh oil, but in the neck of the retort a greater quantity of the ſame aduſt oil, incorporated with a pretty quantity of volatile ſalt, whoſe ſmell did really recall to my mind that peculiar kind of ſtink, which I had ſometimes taken notice of in the volatile ſalt of unfermented urine; nor were the taſtes of theſe two ſalts unlike. The *caput mortuum* conſiſted of a fine, light, coal-black powder, not unlike the fineſt ſort of ſoot; and by weighing but of ſix drachms, informed us, that above two thirds of the diſtilled *calculi humani* had been, as being volatile, forced from the terreſtrial parts, even in a cloſe veſſel, wherein the *caput mortuum*, though it were left inſipid enough, yet retained ſtink enough to make us think it ſtill contained

pretty

pretty ſtore of heavy oil: as indeed, having put it into a crucible, and kept it a competent while in a ſtronger fire, we found it reduced to about two drachms of a brittle maſs of inſipid white calx, which did not ſlack, or fall aſunder like lime, when it is caſt into the water.

Of the changes, that may reaſonably be thought to happen to our aliments within the body.

To this example of the uſefulneſs of chymiſtry, to diſcover the unobſerved, and otherwiſe ſcarce diſcoverable difference of the *calculus humanus* from other ſtones, we may venture to add, that though ſome Paracelſians do take too much liberty, when they crudely tell us, that there are arſenical, vitriolate, aluminous, and other mineral ſubſtances, generated in human bodies; yet if they had more warily propoſed their doctrine, it would not perhaps appear ſo abſurd, as they are wont to think it, who conſidering only the nature of the aliments men uſually feed upon, cannot conceive, that ſuch being but either animals or vegetables, can by ſo gentle a heat as that of man's body, (by which they ſuppoſe all the changes of the aliments muſt be effected,) be exalted to an energy like that of ſuch bodies, as are compoſed of active mineral ſubſtances, and have ſome of them perchance acquired a violence of operation from the fire. But we ſee, that concretions, ſo like ſtones, (which belong to the mineral kingdom) as to paſs generally for ſuch, may be produced in the bodies not only of men but of ſucking children, whoſe aliment is fluid milk: and it ſeems a miſtake to imagine (how many ſoever do ſo) that heat muſt needs be efficient of all the changes the matter of our aliments may happen to undergo in a human body; where there are ſtrainers, and ſolvents, and new mixtions, and perhaps ferments, and divers other powerful agents, which by ſucceſſively working upon the aſſumed matter, may ſo faſhion and qualify it, as, in ſome caſes, to bring the more diſpoſed part of it to be not unlike even foſſile ſalts, or other mineral ſubſtances. A very eminent perſon was lately complaining to me, that in the fits of a diſtemper, which almoſt as much puzzles her phyſicians as herſelf, ſhe ſometimes vomits up ſomething ſo ſharp and fretting, that, after it hath burnt her throat in its paſſage, almoſt like ſcalding water, it doth not only ſtain the ſilver veſſels, that received it, but alſo work upon them as if it were a corroſive menſtruum. And there died a while ſince a very intelligent perſon, much imployed in publick affairs, who complained to me, that in the fits of the ſtrange diſtemper he laboured under, he divers times obſerved, that that part of his pillow, which his breath paſſed along, would by the ſtrange fuliginous ſteams, which that carried off with it, be blacked over, as if it had been held in ſome ſooty ſmoke or other.

Illuſtrated by the example of juices out of the body.

We may alſo conſider, that the rain-water, which in its paſſage through a vine, or an apricock-tree, or the like plants is turned into a ſweet fruit in its paſſage through thoſe plants, that bear lemons and barberries, is tranſmuted into a liquor ſharp enough to corrode; not only pearls but coral, *lapides cancrorum*, and other hard concretes, as ſpirit of vitriol would do. And writers of unſuſpected credit affirm, that an Indian fruit, (whoſe name I cannot readily call to mind) will ſpeedily corrode and waſte the very ſteel knives it is cut with, if its juice be left long upon them: and we ſee, that ſome ſorts even of our apples and pears will quickly black the blades of knives on which the juice is ſuffered to continue. And leſt what I freſhly mentioned about lemon-trees, ſhould be queſtioned, I will here add, that I remember alſo, that I have made not only ſome other hot and ſtrongly taſted herbs, but even a ranunculus it ſelf, to grow and increaſe notably in weight as well as bulk, though I fed it but with fair water; and allowed it nothing elſe to ſhoot its root into. Wherefore ſince this plant is reckoned amongſt thoſe, that either are poiſonous, or want but little of being ſo; and ſince its operation is ſo violent, that this ſort of vegetables is taken notice of from the experience of country people, to be able by outward application to draw bliſters, and ſince nevertheleſs that, which this plant, without any heat diſcernible by the touch, tranſmutes into ſo virulent a ſubſtance, is but ſo unactive a body as water; why may not ſuch aliments, as may have in them divers parts of a far more operative nature, be in a human body, by an unuſual concourſe of cauſes and circumſtances, ſo altered and exalted, as to approach in operations (eſpecially upon the more tender parts) to thoſe of foſſile ſalts or other minerals? So that a chymiſt might upon ſuch an account, without any great abſurdity, teach ſome parcels of morbifick matter to be of an arſenical, or vitriolate, or an antimonial nature, eſpecially ſince we ſee, that ſometimes cancers, ulcers, and ſharp juices generated in the body, do by their vitiating and waſting the invaded parts, but too much emulate the pernicious operations of arſenick, and of fretting ſalts: and the infuſion of antimony doth ſcarce more ſtimulate nature to disburthen her ſelf both upwards and downwards, than doth ſometimes an humour, ſuch as that, which cauſes the *cholera morbus*, and perhaps more violent diſeaſes.

And that ſuch degeneration of innocent aliments ſhould ſometimes happen in diſcompoſed bodies, you will perhaps think the leſs ſtrange, if you duly perpend what I lately mentioned of the tranſmutation of water into hot and veſicatory ſubſtances; and if thereto I annex, that from a ſingle pound of ſo common and temperate an aliment as bread, I can by an eaſy way, (and that without addition) obtain many ounces of a menſtruum, which (as trial has informed) will work more powerfully upon bodies more compact than ſome hard minerals, or perhaps glaſs it ſelf, than a wary chymiſt would expect to ſee aqua fortis do. Theſe things I have mentioned, *Pyrophilus*, to intimate ſome of the reaſons, why I think chymical experiments may be uſefully applied, to illuſtrate ſome things in pathology, either by imitating out of the body the productions of ſome ſorts of morbifick matter, or by ſuch reſolutions as that, which is generated in the body, as may conduce to the diſcovery

of its nature. And not that I think, as Spagyriſts do, the experiments or notions of vulgar chymiſts ſufficient to explicate the whole doctrine either of digeſtion or diſeaſes: for it would be very difficult for them to make out the manner of nutrition, or ſo much as how they, that feed only on vegetables, ſhould (to propoſe the difficulty in their own terms) have their blood and urine copiouſly enriched with a volatile ſulphureous ſalt, of which ſort plants are not wont to yield any in diſtillation. And much more difficult would it be for them, by principles peculiar to chymiſts, to make out the propagation of hereditary diſeaſes: or how madneſs, and ſome other diſtempers, that do not viſibly vitiate the organs of thoſe functions that they pervert, ſhould not only prove hereditary, but lurk very many years in the inheriting perſon's body, before they begin to diſcloſe themſelves; and ſometimes too, be tranſmitted from the grandfather to the grandchild, and ſkip immediately the intervening ſon. And therefore I ſay again, that I pretend not, that vulgar chymiſtry will enable a phyſician to explicate all or moſt of the pathological phænomena; but that true chymiſtry may aſſiſt him to explicate divers of them, which can ſcarce be ſolidly explicated without it. And let me add, that he, that thoroughly underſtands the nature of ferments and fermentations, ſhall probably be much better able than he, that ignores them, to give a fair account of divers phænomena of ſeveral diſeaſes (as well fevers as others) which will perhaps be never thoroughly underſtood, without an inſight into the doctrine of fermentation; in order to which, for that and other reaſons, I deſigned my hiſtorical notes touching that ſubject.

Difference between vulgar and true chymiſtry.

The uſe of the knowledge of fermentation.

YET I am not ſure, but there may be effervescences, (and perhaps periodical ones) in the blood and other juices of the body without fermentation properly ſo called. For there may be divers other ways of begetting a preternatural heat in the blood. We often ſee, that in coughs, when the phlegm is rotten (as they ſpeak) that is, when its former viſcous texture is altered, it does no longer ſtick faſt to the veſſels of the lungs, to which it obſtinately adhered before. And ſo at certain times other humours in the body, either by growing more fluid themſelves, or by ſome change in the blood, whereby it becomes fitter to diſſolve ſuch humours, may ſwim in, and be circulated with the maſs of blood, and thereby occaſion preternatural heats; either by their indiſpoſition to be well incorporated therewith; or by altering its texture; or diſturbing the wonted motion of its minute parts; or by oppoſing its due rarefaction, as it paſſeth through the heat; or by obſtructing the more ſlender veſſels, and ſo hindering the free circulation of the blood through them; perhaps alſo cauſing ſome extravaſation, as we ſee, that wounds and bruiſes are attended with ſome inflammation, more or leſs, of the part affected; or by ſome other of the ways not now to be declared. And trial hath taught me, that there are liquors, in which the bare admixture of milk, oil, or other liquors, nay or of cold water, will preſently occaſion a notable heat: and I ſometimes employ a menſtruum, in which nothing but a little fleſh being put, though no viſible ebullition enſue, there will in a few minutes be excited a heat intenſe enough to be troubleſome to him, that holds the glaſs. And yet it ſeems not neceſſary, that this ſhould be aſcribed to a true fermentation, which may rather proceed from the perturbed motion of the corpuſcles of the menſtruum, which being by the adventitious liquor or other body put out of their wonted motion, and into an inordinate one, there is produced in the menſtruum a briſk confuſed agitation of the ſmall parts, that compoſe it; and in ſuch an agitation (from what cauſe ſoever it proceeds) the nature of heat ſeems mainly to conſiſt. But to diſpatch, I ſcarce doubt, but that if in the hiſtory of diſeaſes, there were better notice taken of thoſe phænomena, that agree not with the opinions already in requeſt, as well as of thoſe, that are thought conſonant to them; and if alſo chymical trials were ſkilfully varied, and judiciouſly applied to this illuſtrating of pathological phænomena, the former might be made conducing to the better explication of the latter: eſpecially if the buſineſs were managed by a naturaliſt well verſed both in chymical experiments, and in anatomy, and the hiſtory of diſeaſes, without being too much addicted either to the chymiſt's notions, or the received opinions of phyſicians.

Of periodical effervescences in the blood without fermentation.

AND as the naturaliſt may thus illuſtrate pathology as a chymiſt, ſo may he do the like as a zoologer; for either the true knowledge of anatomy muſt be much leſs uſeful to phyſicians than they have hitherto believed, or elſe the diſcoveries made by recent anatomiſts of the Aſellian, Pecquetian, and Bartholinian veſſels, by either overthrowing the received doctrine of digeſtions, (from whoſe aberrations many diſeaſes ſpring) or at leaſt by making divers diſcoveries in relation to the oeconomy of digeſtions unknown to the ancients, muſt probably contribute much to the clearing up of divers pathological difficulties in the explication of ſome diſeaſes; beſides that the very liberty of making thoſe experiments in live beaſts, which are not to be made but in living creatures, nor are allowable to be made in living men, may enable a zoologiſt, by giving us a clearer account of divers parts of the body, to determine divers pathological difficulties ſpringing from either our ignorance or miſtakes of the uſe of thoſe parts, as by the formerly mentioned experiment of the exſection of a live dog's ſpleen, and a watchful obſervation of all the diſeaſes upon that account, befalling him and other dogs ſo ſerved; much light perhaps may be given to the doctrine of the uſe of the ſpleen, together with the diſeaſes ſuppoſed to depend upon that part, which I fear is hitherto (to the no ſmall prejudice of the ſick) by few phyſicians throughly underſtood, and by many unhappily enough miſtaken.

Of the uſe of zoology to the knowledge of diſeaſes.

AND here we may repreſent unto you, *Pyrophilus*, that not only the diſſections of found beaſts may aſſiſt the phyſician to diſcover

cover the like parts of a human body, but the diſſections of morbid beaſts may ſometimes illuſtrate the doctrine of the cauſes and ſeats of diſeaſes. For that this part of pathology has been very much improved by the diligence of modern phyſicians, by diſſecting the bodies of men killed by diſeaſes, we might be juſtly accuſed of want of curioſity, or gratitude, if we did not thankfully acknowledge; for indeed much of that improvement of phyſick, (for which the antients, were they now alive, might envy our new phyſicians) may, in my poor opinion, be aſcribed to their induſtrious ſcrutiny of the ſeat and effects of the peccant matter of diſeaſes in the bodies of thoſe that have been deſtroyed by them.

AND that the inſtructions deducible from ſuch obſervations may be either increaſed or illuſtrated by the like obſervations made in the bodies of beaſts, we have been inclined to think, partly by the having chymically analyzed (as they phraſe it) the blood of divers brutes, as ſheep, deer, *&c.* and found its phlegm, ſpirit, ſalt, and oil, very like that of human blood; and partly, by our having obſerved in the bodies of ſeveral brutes, (not excepting fiſhes) worms, impoſthumes, and the like, ſome of which ſeemed manifeſtly to ſpring from ſuch cauſes, as are wont to produce reſembling diſtempers in men. And if the acute *Helmont* had been a more diligent diſſector of beaſts, he would perchance have eſcaped the error he after others run into (and into which his authority hath tempted others to run) when he affirmed, that the ſtone was a diſeaſe peculiar to men; for that in the bodies of beaſts, eſpecially very old ones, ſtones are ſometimes to be found, not only ſeveral butchers have aſſured me, but you may gather partly from that taken out of an ox's gall, which I have formerly mentioned, which was about the bigneſs of a walnut, but principally from what I elſewhere delivered on purpoſe to diſprove that fond aſſertion. And greater leiſure may, upon another occaſion, invite us to mention ſome pathological obſervations made in diſeaſed beaſts, by which (were we not willing to haſten) we might now perhaps much confirm what we have propoſed touching the poſſibility of illuſtrating, by ſuch obſervations, the nature of ſome of the diſeaſes incident to human bodies.

Helmont's error refuted, that the ſtone is a diſeaſe peculiar to man.

AND here we may alſo conſider, that there are divers explications of particular diſeaſes, or troubleſome accidents propoſed by phyſicians, eſpecially ſince the diſcovery of the blood's circulation, wherein the compreſſion, obſtruction, or irritation of ſome nerve, or the diſtenſion of ſome vein by too much blood, or ſome hindrance of the free paſſage of the blood through this or that particular veſſel, is aſſigned for the cauſe of this or that diſeaſe or ſymptom. Now in divers of theſe caſes the liberty lately mentioned, that a ſkilful diſſector may take in beaſts, to open the body or limbs, to make ligatures ſtrong or weak on the veſſels, or other inward parts, as occaſion ſhall require, to leave them there as long as he pleaſeth, to prick, or apply ſharp liquors to any nervous or membranous part, and whenever he thinks convenient, to diſſect the animal again, to obſerve what change his experiment hath produced there: ſuch a liberty, I ſay, which is not to be taken in human bodies, may in ſome caſe either confirm or confute the theories propoſed, and ſo put an end to divers pathological controverſies, and perhaps too occaſion the diſcovery of the true genuine cauſes of the phænomena diſputed of, or of others really as abſtruſe.

To this let me add, that there is a whole claſſis of diſeaſes to be met with in phyſicians books, which proceed not originally from any internal diſtemper of the patient, but are produced by ſome exteriour poiſon, and are therefore wont to be called by doctors, *morbi à veneno orti*, to the more accurate knowledge of divers of which diſeaſes experiments made on brutes may not a little conduce. For though I deny not, that ſome things may be poiſonous to man, that are not ſo to ſome beaſts; and on the contrary (as we have more than once given to a dog, without much harming him, ſuch a quantity of opium, as would probably have ſufficed to have killed ſeveral men) yet the greater number of poiſons being ſuch both to man and brutes, the liberty of exhibiting them, when, and in what manner we pleaſe, to theſe (which we dare not do to him) allows us great opportunities of obſerving their manner of operation and inveſtigating their nature, as ourſelves have tried, and that ſometimes with unexpected events (as when lately a cat ran mad, ſo that her keeper was fain to kill her) upon a large doſe of opium which we cauſed to be given her.

AND on this occaſion I ſhall not ſcruple to tranſcribe one obſervation out of a diſcourſe, I ſome years ſince writ to a friend, about the turning poiſons into medicines, becauſe that treatiſe I am like, for certain reaſons, to ſuppreſs: the words, as I there find them, are theſe.

'BEFORE I take leave of vipers (or adders, as ſome will have thoſe, that here in *England* commonly paſs for vipers) it will not be impertinent to tell you, that it may be juſtly doubted; whether they be to be reckoned amongſt poiſonous creatures, in ſuch a ſenſe as thoſe other venomous creatures, who have in them a conſtant, and, if I may ſo ſpeak, groſs and tangible poiſon; for it may be ſuppoſed, that the venom of vipers conſiſts chiefly in the rage and fury, wherewith they bite, and not in any part of the body, which hath at all times a mortal property: thus the madneſs of a dog makes his teeth poiſonous, which before were not ſo. And authors of good repute ſupply us with inſtances of hurts, in themſelves free from danger, that have been made fatal by a venom created by the fierceneſs of the enraged (though not otherwiſe poiſonous) creatures that inflicted them. And *Baccius*, if I miſtake not, in his treatiſe *de venenis*, tells us a memorable ſtory (whereof he affirms himſelf to have been an eye-witneſs) of a man, who was killed within three days, by a ſlight hurt received in his left hand, from an enraged dunghill-

That the venom of vipers or adders conſiſts chiefly in the rage and fury, wherewith they bite, and not in any part of the body that hath at all times a mortal property.

'dunghill-cock; and that no parts of the viper 'have any conſtant inherent poiſon in them, 'I have been induced to ſuſpect upon this ex- 'periment, that diſſecting ſome live vipers, 'there came in accidentally a ſtrange dog, to 'whom I gave the head, tail, and gall, (which 'are the parts ſuppoſed to contain the poiſon) 'of one of them; and the head and gall of ano- 'ther, wrapt up in meat; after which I locked 'the little dog up in my own chamber, and 'watched him; but found not, that he was 'ſick, or offered to vomit at all, but only lap- 'ped up greedily ſome drink, which he eſpied 'in the room: nor was he alone very jocund, 'for divers hours that I kept him in, but 'liked his entertainment ſo well, that he would 'afterwards, when he met me in the ſtreet, 'leave thoſe, that kept him, to fawn on and 'follow me. And having ſince related this 'experiment to an inquiſitive friend of mine, 'he aſſured me, that to ſatisfy himſelf further 'in this particular, he gave to a dog a dozen 'heads and galls of vipers, without finding 'them to produce in him any miſchievous 'ſymptom. To which I ſhall add, that the 'old man you know, that makes viper-wine, 'does it (as himſelf tells me) by leaving the 'whole vipers, if they be not very great, per- 'haps for ſome months, without taking out 'the galls, or ſeparating any other part from 'them in the wine, till it hath diſſolved as 'much of it as it can.

'AND though it may ſeem ſomewhat im- 'proper, whilſt we are diſcourſing of poiſons, 'to inſiſt on a remedy againſt them; yet the 'mention of vipers recalling into my mind a 'memorable experiment, which I tried againſt 'the biting of vipers, I ſhall chuſe rather to 'decline the dictates of method, than thoſe 'of charity, which forbids me to ſuppreſs a 'remedy, that may poſſibly reſcue from ſudden 'death a perſon or other fit to live, or un- 'prepared to die; becauſe it does not ſtrictly 'belong to the theme, whereto it is referred.

A certain cure for the biting of vipers.

'The remedy then is this, that as ſoon as ever 'a man is bitten, (for if the poiſon have had 'time enough to diffuſe it ſelf, and gain the 'maſs of blood, I doubt the experiment will 'ſcarce ſucceed) a hot iron be held as near 'the place, as the patient can poſſibly endure, 'till it have, as they ſpeak, drawn out all the 'venom: which eye-witneſſes aſſure me (for 'I have not yet ſeen that my ſelf) will ſome- 'times adhere like a yellowiſh ſpot to the ſur- 'face of the iron. But being upon competent 'grounds ſatisfied of the experiment, to con- 'vince a phyſician, that miſtruſted it; I laſt 'ſummer hired a man (who doubted it as little 'as I) to ſuffer himſelf to be bitten by a viper; 'and having in the phyſician's houſe and 'preſence picked out of a good number of 'them, one of the blackeſt I could find (thoſe 'of that colour being ſuppoſed the moſt miſ- 'chievous) and commanded the fellow to pro- 'voke and anger it, (which to my wonder he 'did, a pretty while before the beaſt would 'faſten on him;) at length being by his very 'rude handling thoroughly exaſperated, it 'bit him with great fury, as it ſeemed: for 'immediately his hand began to ſwell, and 'the injured part was grown tumid, before we 'could take from the fire, which was hard by, 'a knife, that lay heating there; and having 'applied it as near as he could ſuffer it, for 'about ten or twelve minutes, we found, that 'the ſwelling, though it decreaſed not, did not 'ſpread, and the man glad of his money, with- 'out farther ceremony, went about his affairs, 'and told me ſince, that though the tumour 'continued a while, he had no other incon- 'venience attending it, and hath divers times 'got money by repeating the experiment; 'though otherwiſe, by the caſual bitings of 'vipers, he hath been much diſtreſt, and his 'wife almoſt killed.'

BUT, *Pyrophilus*, to return to the experiments of poiſons made on beaſts, we could wiſh phyſicians were more diligent to make trials of them, not only by giving beaſts poiſons at the mouth, but alſo by making external applications of them, eſpecially in thoſe parts, where the veſſels, that convey blood, more approach the ſurface of the body, and alſo by dexterouſly wounding determinate veins with inſtruments dipt in poiſons (eſpecially moiſt or liquid ones) that being carried by the circulated blood to the heart and heat, it may be found, whether their ſtrength be that way more uninfringed, and their operation more ſpeedy (or otherwiſe differing) than if they were taken in at the mouth. For I remember ſober travellers have ſhewed me ſome Indian poiſons, whoſe noxious efficacy they affirmed to be, by great intervals of time, differingly mortal, according as the ſlight hurt made by the points of arrows, infected with them, did open a capillary or larger vein, and were inflicted on a part more or leſs diſtant from the heart; but having not yet made any trial of this my ſelf, I dare not build upon it. Yet I find, that the formerly commended *Olearius*, in his travels into *Muſcovy* and *Perſia*, takes notice of a venomous inſect in *Perſia*, which the natives call *Encureck*, and which he (how juſtly I know not) makes to be a kind of *Tarantula*, becauſe it is, as that creature, in ſhape almoſt like a ſpider, and ſpeckled, though of twice the bigneſs of a thumb: this inſect (ſays he) inſtead of ſtinging or biting, lets his venom fall in form of a drop of water, which immediately produces inſufferable pains in the part to which it faſtens; and ſuddenly penetrating as far as to the ſtomach, ſends up vapours to the head, which ſends again (to uſe his expreſſion) ſo profound a ſleep to all the patient's limbs, that it is impoſſible to awaken him, but by one only remedy, which is to cruſh one of theſe creatures upon the hurt, whence he abſtracts all the poiſon. Some horrid and unuſual ſymptoms of this venom, which yet agree not ſo well with thoſe, that are wont to be produced in perſons bitten by *Tarantula's*, our author proceeds to mention; and furniſhes us with a proof of what we were lately ſaying, when we told you, that ſome things were poiſonous to men, which were not to ſome beaſts; by adding, as an admirable ſingularity, that the ſheep of thoſe parts do not only eat theſe

Of external application of poiſons, and letting them into the veins of beaſts.

Voyage de Moſcovie & de Perſe, pag. 334.

fatal

fatal inſects, but ſeek for them. I know alſo, by ſad experience in my ſelf, what an outward application even of cantharides can do; for having occaſion to have a large bliſter drawn on my neck, the chirurgeon I employed, unknown to me, made uſe of cantharides, among other ingredients of his veſicating plaiſter, which, a few hours after I had taken it, wakened me with exceſſive torment, to which it put me about the neck of my bladder, ſo that I apprehended it might proceed from ſome ſtone unable to get out; of which ſudden and ſenſible pain, after I had a while in vain conjectured, what might be the cauſe, I at length ſuſpected that, which was indeed the true one; and having ſent for the chirurgeon, he confeſſed to me, upon my demand, that he had put ſome cantharides in his plaiſter, not thinking it would have had ſuch an operation: whereupon I ſoon relieved my ſelf, by drinking new milk very well ſweetened with ſugar-candy.

POSTSCRIPT.

TO enable you, *Pyrophilus*, to gratify thoſe inquiſitive perſons, that have heard ſome, and yet but an imperfect report, of a much noiſed experiment, that was ſome years ago deviſed at *Oxford*, and ſince tried in other places before very illuſtrious ſpectators; I am content to take the occaſion afforded me, by what was in the foregoing eſſay lately mentioned concerning the application of poiſons, to inform you, that a pretty while after the writing of that eſſay, I happened to have ſome diſcourſe about matters of the like nature, with thoſe excellent mathematicians, Dr. *J. Wilkins*, and Mr. *Chriſtopher Wren*; at which the latter of thoſe virtuoſi told us, that he thought he could eaſily contrive a way to convey any liquid poiſon immediately into the maſs of blood. Whereupon our knowledge of his extraordinary ſagacity making us very deſirous to try what he propoſed, I provided a large dog, on which he made his experiment in the preſence, and with the aſſiſtance of ſome eminent phyſicians, and other learned men. His way (which is much better learned by ſight than relation) was briefly this: firſt, to make a ſmall and opportune inciſion over that part of the hind-leg, where the larger veſſels, that carry the blood, are moſt eaſy to be taken hold of: then to make a ligature upon thoſe veſſels, and to apply a certain ſmall plate of braſs (of above half an inch long, and about a quarter of an inch broad, whoſe ſides were bending inwards) almoſt of the ſhape and bigneſs of the nail of a man's thumb, but ſomewhat longer. This plate had four little holes in the ſides, near the corners, that, by threads paſſed through them, it might be well faſtened to the veſſel. And in the ſame little plate there was alſo left an aperture, or ſomewhat large ſlit, parallel to the ſides of it, and almoſt as long as the plate, that the vein might be there expoſed to the lancet, and kept from ſtarting aſide. This plate being well faſtened on, he made a ſlit along the vein, from the ligature towards the heart, great enough to put in at it the ſlender pipe of a ſyringe, by which I had propoſed to have injected a warm ſolution of opium in ſack, that the effect of our experiment might be the more quick and manifeſt. And accordingly our dextrous experimenter having ſurmounted the difficulties, which the tortured dog's violent ſtrugglings interpoſed, conveyed a ſmall doſe of the ſolution or tincture into the opened veſſel, whereby, getting into the maſs of blood (ſome quantity of which, it is hard to avoid ſhedding in the operation) it was quickly, by the circular motion of that, carried to the brain, and other parts of the body. So that we had ſcarce untied the dog (whoſe four feet it had been requiſite to faſten very ſtrongly to the four corners of the table) before the opium began to diſcloſe its narcotick quality; and almoſt as ſoon as he was upon his feet, he began to nod with his head, and faulter and reel in his pace, and preſently after appeared ſo ſtupified, that there were wagers offered his life could not be ſaved. But I, that was willing to reſerve him for further obſervation, cauſed him to be whipped up and down a neighbouring garden, whereby being kept awake and in motion, after ſome time he began to come to himſelf again, and being led home, and carefully tended, he not only recovered, but began to grow fat ſo manifeſtly, that it was admired: but I could not long obſerve, how it fared with him; for this experiment, and ſome other trials I made upon him, having made him famous, he was ſoon after ſtolen away from me. Succeeding attempts informed us, that the plate was not neceſſary, if the finger were ſkilfully employed to ſupport the veſſel to be opened; and that a ſlender quill, faſtened to a bladder, containing the matter to be injected, was ſomewhat more convenient than a ſyringe; as alſo, that this notwithſtanding, unleſs the dog were pretty big, and lean, that the veſſels might be large enough and eaſily acceſſible, the experiment would not eaſily ſucceed. The inventor of it afterwards practiſed it in the preſence of that moſt learned noble man, the Marquis of *Dorcheſter*, and found, that a moderate doſe of the infuſion of *crocus metallorum* did not much move the dog, to whom it was given: but once that he injected a large doſe (about two ounces or more) it wrought ſo ſoon, and ſo violently upon a freſh one, that within a few hours after, he vomited up life and all, upon the ſtraw, whereon they had laid him. I afterwards wiſhed, that not only ſome vehemently working drugs, but their appropriated antidotes, (or elſe powerful liquid cordials) and alſo ſome altering medicines, might be in a plentiful doſe injected. And in diureticks a very ingenious anatomiſt and phyſician told me, he tried it with very good ſucceſs. I likewiſe propoſed, that if it could be done, without either too much danger or cruelty, trial might be made upon ſome human bodies, eſpecially thoſe of malefactors. And ſome months after, a foreign ambaſſador, a curious perſon, at that time reſiding in *London*, did me the honour to viſit me, and informed me, that he had cauſed trial to be made with infuſion of *crocus metallorum*, upon an inferiour domeſtick of his, that deſerved to have been

Experiments of conveying liquid poiſons immediately into the maſs of blood.

been hanged; but that the fellow, as ſoon as ever the injection began to be made, did (either really or craftily) fall into a ſwoon, whereby being unwilling to proſecute ſo hazardous an experiment, they deſiſted; without ſeeing any other effect of it, ſave, that it was told the ambaſſador, that it wrought once downward with him, which yet might, perhaps, be occaſioned for fear or anguiſh. But the trials of a very dextrous phyſician of my acquaintance, in human bodies, will perhaps, when I ſhall have received a more circumſtantial account of them, be not unwelcome to you. And in dogs, you may poſſibly, from our own obſervations, receive a further account of an experiment; of which, I now chiefly deſigned but to relate to you the riſe and firſt attempts.

ESSAY III.

Containing ſome particulars relating to the Semeiotical part of Phyſick.

THE ſemeiotical part of the phyſician's art ſeems capable of the leaſt improvement by natural philoſophy. In which yet, firſt the naturaliſt may, by illuſtrating the anatomical and pathological parts, aſſiſt the phyſician to make more certain conjectures from the ſigns he diſcovers of the conſtitution and diſtempers of his patient. For you will eaſily believe, that, *cæteris paribus*, he, that better knows the nature of the parts and juices of the body, will be better able to conjecture at the events of diſeaſes, than he that is leſs ſkilled in them. And ſecondly, the naturaliſt by improving the therapeutical, may at leaſt much change and alter the prognoſticks of the duration, ferocity, and event of diſeaſes. For, *Pyrophilus*, it would be conſidered, that the predictions hitherto current in authors, and commonly made by phyſicians, ſuppoſe the uſe of the received remedies, and the dogmatical method of phyſick; but if there were diſcovered ſuch generous and commanding medicines, as, by powerfully aſſiſting nature, or nimbly proſcribing the morbifick matter, that doth either produce, or (though produced by them) cheriſh ſickneſſes, might enable nature to hinder the diſeaſe from continuing its courſe, and acting almoſt all the ſcenes of its tragedy in the body; phyſicians need not, in acute diſeaſes, wait ſo often for a criſis to inſtruct their prognoſticks; and the threatening ſymptoms of chronical diſtempers would often prove falſe prophets.

That the improvement of the therapeutical would alter the prognoſticks in the ſemeiotical part of phyſick.

To illuſtrate this but with a not ignoble inſtance, give me leave to tell you, that when that Peruvian bark, that now begins to be ſomewhat taken notice of, under the name of the Jeſuits powder, had ſcarce been ſo much as heard of in this part of *Europe*, I went to viſit a virtuoſo, who had been for ſome months afflicted with a quartan ague, ſo violent and ſtubborn, that it had fruſtrated the ſkill, and almoſt tired the endeavours of the moſt eminent doctors of this nation; of one of which, who was then accidentally with his learned patient, I inquired how my friend did, and was anſwered, that he hoped he would recover, when the ſeaſon would give him leave; but in the winter he knew no quartans cured. Yet the gentleman acquainting me with his having procured ſome of the American bark againſt agues, which we mentioned in a former eſſay, and I (after having taſted and conſidered it) having encouraged him, as I have others, to make trial of it, as the ſtrange effects I have obſerved of it have divers times invited me to do; the candid and learned doctor not only oppoſed not my perſuaſions, but added his own to them. And my friend taking two doſes of this powdered bark, though it were at the unhopeful ſeaſon of the year (the winter ſolſtice) and though he ſcarce found any ſenſible operation (unleſs a little by ſweat) of the Peruvian medicine, had by the firſt doſe his fit very much leſſened, and by the ſecond quite removed. And though through ſome irregularities of diet (to which that keen appetite, like that of recovering perſons, which I have obſerved this powder to be wont to produce, tempted him) he did, as I then foretold him he would, after miſſing eight or ten fits, relapſe; yet by the repeated uſe of the ſame remedy, he again recovered, and hath continued ſo ever ſince. Having alſo lately perſuaded the uſe of the ſame medicine, in the ſame diſeaſe, to one of the greateſt ladies in this nation, ſhe told me the other day, that it immediately, and in unlikely weather, freed her from thoſe fits, from whence ſhe deſpaired to be delivered till the ſpring. Having likewiſe ſent ſome of it to a couple of gentlemen, ſick of the like malady, I had word brought me, that one had miſſed his fits for a month, though in the midſt of winter; and the other was by the firſt doſe cured, and continues ſo. And divers eminent phyſicians, to whom I have commended the ſpecifick, have uſed it with ſuch ſucceſs, that one of the ſevereſt of them, though he had formerly deſpiſed it, confeſſed to me, that in a ſhort time he tried it upon eight or nine ſeveral perſons, without finding it to fail in any, though one of them eſpecially were, before he was called, judged irrecoverable; the obſtinate quartan being complicated with other almoſt as dangerous diſtempers. And I confeſs I ſomewhat wonder, that men have not the curioſity to try the efficacy of this powerful bark

An inſtance to that purpoſe in the Peruvian bark.

in other diſeaſes than agues; it being highly probable, that a medicine, capable to prevail ſo ſtrongly againſt ſo obſtinate a diſeaſe as a quartan, (wherein moſt commonly divers of the conſiderable parts of the body are much affected) cannot be uſeleſs to ſeveral other diſtempers. I deny not, that thoſe, that have taken this powder, have divers of them, after having miſſed ſix or ſeven fits, relapſed into them, (as it likewiſe happened to one of the gentlemen I ſent it to) yet (as I have elſewhere told you) it is much, and more than any common remedy does, to ſtop the fit ſo long. Nor is it a ſmall matter to be able to give the patient ſo much breathing time, and allow the phyſician the opportunity of imploying other remedies. And the relapſes we ſpeak of, are commonly cured by the ſame powder; and we have known them prevented, when the medicine hath been adminiſtred, not by unſkilful perſons, but by a prudent phyſician, who knows how to aſſiſt it, by opening and gently purging phyſick. Wherefore that, which I ſhould be moſt gladly ſatisfied of about this remedy, is, whether or no it do indeed, either proſcribe the morbifick matter, or ſo alter its texture as to make it harmleſs; or elſe, whether it doth ſecretly leave ſuch noxious impreſſions upon the ſpleen, guts, or ſome other important part, as may ſhorten life, by producing in proceſs of time, either the ſcurvy, or the dropſy, or ſome other formidable diſeaſe. But becauſe the reſolution of this doubt muſt be a work of time, we muſt at preſent refer it to future obſervation: and therefore ſhall now ſubjoin, that if the famous *Riverius* have not, in his learned obſervations, flattered his own *febrifugum*, whatever he reſolved touching this Indian bark, there will not want a ſafe remedy, which may allow phyſicians to make more chearful predictions about the laſtingneſs and event of quartans, than have hitherto been uſual.

And in Riverius's Febrifugum, *and a new cure of the King's-evil.*

Riverius *in obſervat.*

How painful and ſtubborn a diſeaſe the King's-evil is wont to prove, is ſcarce more known, than that it is ſeldom cured without a tedious courſe of phyſick: and yet by the herb mentioned in one of the former eſſays, the young gentleman there ſpoken of was cured in a ſhort time, and with little or no pain or trouble. And that theſe are not the only diſeaſes, in which obſervations, tending to our preſent purpoſe, may be made, the following part of this treatiſe will afford you opportunity to obſerve.

Vide infra, c. 9.

I MIGHT add, *Pyrophilus*, that I was lately viſited by an ancient chymiſt, enobled by divers eminent cures, who promiſeth to me an experiment of making very unuſual, and yet rational predictions in ſome abſtruſe diſeaſes, by a peculiar way of examining the patient's urine. But becauſe ſome chymiſts have written extravagantly enough upon a like ſubject, and becauſe I have not yet made or ſeen the experiment of it my ſelf, I dare not yet give this new method of foretelling, for an inſtance of the uſefulneſs of natural philoſophy to the ſomeiotical part of phyſick. Though I dare not deny but by precipitations, and ſome other ways, not yet vulgarly practiſed, of examining the urine, made by the ſame patient at ſeveral times, before, in, and after ſome notable alteration in his body, divers things (eſpecially in fevers, and other acute diſeaſes) relating to the ſtate of it, may be diſcovered, eſpecially if thereto be added a ſkilful and ſeaſonable chymical examen of the other excrements, and vitiated ſubſtances of the patient's body.

YOU will perchance expect, *Pyrophilus*, that on this occaſion I ſhould handle that controverſy, which is ſo hotly agitated betwixt the Paracelſians and their adverſaries, concerning the curableneſs of all diſeaſes: but, for aught I can perceive, the difference betwixt the more ſober men of both parties is more about words than things, and might be reduced to a much leſs diſtance, if men could but calmly conſider, that it is one thing to diſpute, whether all diſeaſes be curable, and another, whether all perſons be recoverable? For a diſeaſe may be called incurable, either in its own nature, or by accident; that is, either becauſe ſuch a diſeaſe is not to be cured in any patient, or that it is ſo circumſtantiated in this or that patient, as not to be naturally curable in him. Now this diſtinctly and duly conſidered may conduce much to reconcile the two opinions, if not the parties that maintain them; for neither would a ſober Paracelſian affirm, (though *Paracelſus* himſelf doth ſomewhere ſeem to do ſo,) that every diſeaſe is curable in every patient, there being ſome palſies, gouts, or blindneſſes, or the like, ſo obſtinate, that (eſpecially if they are born with a man, or inherited from his parents) the tone of ſome neceſſary or conſiderable part of the body being thereby rather aboliſhed, than barely vitiated, it were a folly to promiſe recovery to ſuch a patient. And on the other ſide, a moderate Galeniſt, that is not unacquainted with the diſcoveries, which theſe latter ages have made of the power of nature and art, will not be forward to pronounce (as others do, and as the Paracelſians tax the Galeniſts too indiſcriminately for doing,) that the gout, (for inſtance) the dropſy, the dead palſy, and the ſtone, are diſeaſes univerſally incurable; ſince in the writings of *Eraſtus*, and in the obſervations of *Schenckius*, and others, there are inſtances recorded of ſome cures performed of the dropſy, and one or two more of thoſe ſtubborn diſeaſes, even by Galenical remedies.

That though no diſeaſe ſhould be incurable, yet every diſeaſe is not curable in every patient.

BUT, *Pyrophilus*, though we cannot but diſapprove the vain-glorious boaſts of *Paracelſus* himſelf, and ſome of his followers, who, for all that, lived no longer than other men; yet I think mankind owes ſomething to the chymiſts, for having put ſome men in hope of doing greater cures than have been formerly aſpired to, or even thought poſſible, and thereby engage them to make trials and attempts in order thereunto. For not only before men were awakened and excited by the many promiſes and ſome great cures of *Arnoldus de Villanova*, *Paracelſus*, *Rulandus*, *Severinus*, and *Helmont*, many phyſicians were wont to be too forward to pronounce men, troubled with ſuch and ſuch diſeaſes, incurable, and rather detract from nature and art, than con-

That the hope of doing greater cures than ordinary hath engaged artiſts to make profitable trials.

feſs, that thoſe two could do what ordinary phyſick could not; but even now, I fear, there are but too many, who, though they will not openly affirm, that ſuch and ſuch diſeaſes are abſolutely incurable, yet if a particular patient, troubled with any of them, be preſented, they will be very apt to undervalue (at leaſt) if not deride thoſe, that ſhall attempt and hope to cure him.

AND I am apt to think, that many a patient hath been ſuffered to die, whoſe life might have been ſaved, if phyſicians would have but thought it poſſible to ſave it. And therefore I think it were no ill piece of ſervice to mankind, if a ſevere collection were made of the cures of ſuch perſons, as have recovered of having been judged irrecoverable by the doctors; that men might no longer excuſe their own ignorance by the impotency of nature, and bear the world in hand, as if the art of phyſick, and their ſkill, were of the ſame extent. And the cures, that ſeem performed by nature her ſelf, need not be left out of ſuch a collection: for ſtill they ſhew what is poſſible to be done by natural means, to evacuate the morbifick matter, or alter its nature (how dangerous ſoever it is grown,) or how far the tone of a part, or ſtrength of the body may be vitiated or impaired, and yet be capable of ſome reſtitution. And ſuch an obſervation I received from our moſt experienced *Harvey*, when, having conſulted him about my weak eyes, he told me, among other things (as a very remarkable one) that he had once a patient (whoſe name and profeſſion he told me, but I remember not) that had a confirmed cataract in his eye; and yet upon the uſe of phyſick, to which he could not aſcribe ſo wonderful an effect, that cataract was perfectly diſſipated, and the eye reſtored to its wonted function. Which brings into my mind another obſervation, imparted to me a while ſince by that excellent and experienced lithotomiſt, Mr. *Hollyer*, who told me, that among the many patients ſent to be cured in a great hoſpital (of which he is one of the chirurgeons) there was a maid of about 18 years of age, who, without the loſs of motion, had ſo loſt the ſenſe of feeling in the external parts of her body, that when he had, for trial ſake, pinned her handkerchief to her bare neck, ſhe went up and down with it ſo pinned, without having any ſenſe of what he had done to her. He added, that this maid having remained a great while in the hoſpital without being cured, Dr. *Harvey*, out of curioſity, viſited her ſometimes, and ſuſpecting her ſtrange diſtemper to be chiefly uterine, and curable only by hymeneal excerciſes, he adviſed her parents (who ſent her not thither out of poverty) to take her home, and provide her a huſband, by whom, in effect, ſhe was, according to his prognoſtick, and to many men's wonder, cured of that ſtrange diſeaſe. That in acute ſickneſſes perſons given over by the phyſicians may recover, the more judicious, even of thoſe Galeniſts, that are of a deſpondent temper, will not deny. For not only *Celſus* gives us this ſober admonition, *Neque ignorare oportet in acutis morbis fallaces magis notas eſſe & ſalutis & mortis:* 'Nor may we be ignorant, that in 'acute diſeaſes, the notes of life or death are 'more fallacious:' But even *Hippocrates* himſelf, who was ſo ſkilful in prognoſticks, confeſſes, that *Morborum acutorum non in totum certæ ſunt prænunciationes neque ſalutis neque mortis:* whence the French have a proverbial ſaying, that *Il vaut mieux eſtre condamné par les medicins, que par le prevoſt des mareſchaux*; as if in Engliſh we ſhould ſay, "it is better to "be condemned to die by the doctor, than by "the judge." And even in chronical diſeaſes, where events are wont much better to anſwer phyſicians predictions, there are ſometimes ſuch cures performed, as may encourage human induſtry, and keep a ſick man's friends from forſaking the cure of him, till life it ſelf hath unqueſtionably forſaken him. For not only it hath been not unfrequently ſeen, that divers perſons, who have been given over by ſome phyſicians, have been cured by others, perchance rather more lucky than more ſkilful; but thoſe, that have been given over, and that too (ſometimes rather upon the believed incurableneſs of the diſeaſe, than the perſonal condition of the patient) even by judicious and experienced phyſicians, if ſuch as are acquainted but with the ordinary remedies, have been recovered by the uſe of extraordinarily powerful, and eſpecially, chymical phyſick. Of ſuch cures I have ſometimes met with a few, which, becauſe I may elſewhere relate, I ſhall now only mention, on this occaſion, what I have heard concerning the cures of cancers, performed by Dr. *Harberfeld*, one of the principal phyſicians of *Bohemia*. And among other relations of this kind, made me by credible perſons, I cannot omit one, that was of a certain Engliſh woman, of ſixty and odd years of age, who had long lain in an hoſpital in *Zeeland*, ſick of a cancer in the breaſt, and by this doctor was, with one ſingle inward remedy, perfectly cured in the ſpace of three weeks. For this relation was made me by perſons of very ſtrict veracity, the one a doctor of phyſick, who was an eye-witneſs of the cure; the other a child of *Cornelius Drebell*'s, who not only ſaw the cure, but knew the woman before, and out of charity brought her to him, that healed her. The ſame perſons likewiſe informed me, that the chymical liquor the doctor conſtantly made uſe of, does, in the doſe of about a ſpoonful or two, work ſuddenly and nimbly enough by vomit, but hath very quickly ended its operation; ſo that within an hour or leſs, after the patient hath taken it, he is commonly well again, and very hungry. And they having preſented me ſome ſpoonfuls of this liquor, I find the taſte to be offenſive enough, and not unlike that of vitriol, which, by the taſte and emetick operation, I gueſs to be, at leaſt, its principal ingredient, however it be prepared. The ſame perſons aſſured me, that having obtained of Dr. *Harberfeld* a good quantity of his ſpecifick, they had been (in *England*, as well as elſewhere) partly eye-witneſſes, and partly performers of wonderful cures by the help of it alone under God, in the king's-evil.

Examples of ſome unexpected and ſtrange cures.

Examples of cures of cancers.

evil. Inſomuch that an eminent gentleman of this nation, now alive and healthy, hath been cured by it, when the king's-evil had brought his arm to that paſs, that the chirurgeon had appointed a time to cut it off. And with the ſame liquor, only taken inwardly, they profeſs themſelves to have ſeen and done divers cures of inveterate external ulcers, whoſe proud fleſh, upon the taking of it is wont to fall off, and then the ulcer begins to heal at the bottom; but of the recent effects of this liquor, we may elſewhere, perhaps, further entertain you.

An example of the cure of one, that was born with a cataract in the eye.

That ſuffuſions or cataracts may, by a mutual operation be cured even in a patient, that was born with them, I formerly told you, when I related the cure done by my ingenious acquaintance, Mr. *Stepkins*, on a gentlewoman of about eighteen years of age, that brought a couple of cataracts with her into the world.

And other examples of cataracts ſtrangely cured.

And I remember, I was ſome while ſince in the company of another woman, who told me, that ſhe was brought to bed of five children (if I much miſtake not the number) ſucceſſively; of which ſhe ſaw not any in a long while after, by reaſon of a couple of ſuffuſions, that had many years blinded her; and yet now, by the help of a Dutch oculiſt of my acquaintance, ſhe ſees, and reads well, and hath freely enjoyed the reſtored uſe of her eyes for ſome years already.

BUT theſe are rather chirurgical, than medicinal cures; and therefore we ſhall ſubjoin the mention of a very memorable obſervation of the learned *Petronius*, which being collated with that a little above recited from Dr. *Harvey*, they may ſerve to keep each other from paſſing for incredible: *Quidam* (ſays our author) *qui antequam morbo Gallico afficeretur, altero oculo cæcus erat, ſuffuſione denſiſſima (vulgus cataractam vocat) oculum occupante, hydrargyri inunctione à morbo Gallico, et à ſuffuſione, quod maximè mirum eſt, evaſit. Neque à ratione alienum eſt inunctione illa cataractas poſſe diſſolvi, cum frequens experientia doceat præduros tumores ex pituita craſſa & concreta genitos, illitu hydrargyri potenter diſſolvi.* 'One, who before 'he fell into the French pox was blind of a ca'taract in one of his eyes by being anointed 'with quick-ſilver, was recovered, not only 'from the chief diſeaſe, but (which was moſt 'ſtrange) from his cataract. Nor is it irra'tional, that cataracts ſhould be diſſolved by 'ſuch anointing; when experience teacheth, 'that hard tumours clogged together of pitu'itous matter are powerfully diſſolved by 'mercurial inunctions.'

Alexand. Trajan. Petronius lib. 5. De morb. Gallico, c. 1. apud Scheuchium in obſerv. l. 1.

I NEED not tell you what ſad prognoſticks phyſicians are wont to make of dropſies, eſpecially of that ſort, which they call *Aſcites*. And indeed the event does but too frequently juſtify their predictions, when none but ordinary remedies are imployed. But I remember, that being acquainted with an ingenious perſon, that was very happily cured of a dropſy, and inquiring who it was, that had performed the cure; I was informed, that that, and a multitude of the like, had been wrought by a German phyſician, of whom, and of his remedy, I had heard much commendation in *Holland*, where he lived. And though on divers occaſions I found him a modeſt man, and accordingly, when I aſked him concerning his cures of the dropſy, he anſwered me, that he neither did, nor would undertake to cure ſo formidable a diſeaſe; yet he ſcrupled not to tell me, that as far as he had hitherto tried, he had one remedy, which had not failed him, though he had tried it upon perſons of differing ages, ſexes, and complexions. But of this ſpecifick more hereafter. For, at preſent; I muſt proceed to take notice, that as incurable a diſeaſe, as the radicated gout is thought to be, (eſpecially in patients not very temperate;) and as tedious a courſe of phyſick, as one would expect to be requiſite to the cure of it, in caſe it can be cured; yet I have been ſeveral times viſited by an honeſt merchant of *Amſterdam*, who was there noted for his wealth, and his ſkill *in arte tinctoria*. This man, ten or twelve years ago, had been for a long time ſo tormented with the gout, both in hands and feet, that his fits would ſometimes vex and confine him for a great part of the year, and not leave him without hard knots, as unwelcome pledges of their return: but once, that he was tortured to a degree, that made him much pitied, one came and informed him of an empirick, who had received from a great chymiſt, who had lodged in his houſe, a ſecret, with which he had already throughly cured many in a ſhort time: whereupon ſending for this perſon, and offering him any thing for ſome relief, the other refuſed to take above ten crowns, which, as it ſeems, was the uſual rate for the cure, and would not receive that neither, until the reality of it had been evinced by the patient's continuing about ſix months well. And accordingly, with a very few doſes of a certain powder and tincture, the merchant was quickly freed, not only from his pains, but from his gouty tophy. And though he indulged himſelf the drinking of Rheniſh wine very freely, yet he never had a fit ſince, as himſelf aſſured me one morning, wherein, for exerciſe ſake, he walked five or ſix miles to give me a viſit; adding, that the man that cured him, dying ſuddenly, never could diſcover what the ſecret was, wherewith ſo many had been freed from a diſeaſe, that does ſo often mock the ſkill of the greateſt doctors.

Examples of the cure of the dropſy and gout.

I MIGHT, perhaps, if I had leiſure, relate to you ſome other ſtrange ſtories, which may invite you to think, that as the naturaliſt's ſkill in chymiſtry, and other arts retaining to phyſiology, may much aſſiſt him to diſcover more generous remedies, than are yet uſual; ſo the knowledge of ſuch remedies may, in divers caſes, make a happy change in the rules of prognoſticating, what will prove the courſe and event of a ſickneſs. But I ſhall not, at preſent, particularly conſider any more than one diſeaſe, namely, the ſtone in the bladder. For whereas it is by moſt, even of the judicious phyſicians, unanimouſly pronounced incurable by phyſick in what perſon ſoever, if it deſerve the name of a ſtone, and be too big to be voided whole, the remedileſſneſs of this diſeaſe may be juſtly queſtioned. I remember the famous

famous *Monardes*, treating of the ſeed of a Peruvian plant, which they call *Chalchoos*, tells us, that it is highly eſteemed by the inhabitants of the country it grows in, and affirmed not only to be diuretick, and to bring away gravel, but to break the ſtone in the bladder itſelf, if it be not too much hardened: *Ejuſque rei* (adds he) *tam multa proferunt exempla, ut admirationem mihi pariat:* 'And they urge 'many inſtances of it even to my admiration.' He tells us indeed, that he is of opinion, that nothing but ſection can cure the ſtone of the bladder: *Aiunt tamen*, ſaith he, *illius ſemen* (of the *Chalchoos*) *tritum, ex aqua aliqua ad eam rem idoneâ ſumptum, calculum in lutum diſſolvere, quod excretum denuo concreſcit, & in lapideam duritiem convertitur. Adoleſcentem vidi, cui hoc obtigiſſe ſcio; is cum veſicæ calculo torqueretur, idque à lithotomis, qui calculum deprehenderant, intellexiſſem, & ex ſymptomatis quæ patiebatur agnoſcerem; hominem, veris initio, ad fontem, qui à Petro nomen habet, ablegavi, ubi cum duos menſes hæſiſſet, à calculo liberatus redit, & lutum omne, quod paulatim ejecerat, denuo in lapidum fragmenta concretum in charta ſecum retulit.* 'Yet they ſay, that the ſeed of 'the *Chalchoos*, ground and taken in any pro-'per water, doth diſſolve the ſtone into a very 'dirt, which being voided, doth harden a-'gain into a ſtony ſubſtance. I ſaw a young 'man, to whom (upon my knowledge) this 'accident befel. When he was tormented 'with the ſtone in the bladder, which I under-'ſtood both by the lithotomiſt who felt it, and 'by the ſymptoms which he ſuffered; I ſent 'him to a fountain, which takes its name from 'St. *Peter:* when he had ſtaid there two 'months, he returned free from the ſtone, and 'brought home with him all the dirt, which 'he had voided by degrees, in a paper, coagu-'lated as it were into fragments of ſtone.' Which paſſage, I wonder ſuch a writer ſhould immediately annex to the declaration of an opinion, that muſt appear confuted by it, to a reader, that conſiders not ſo much what is thought, as what is proved.

Examples of the cure of the ſtone.

THE very learned and experienced Dr. *Gerard Boot*, of whoſe ſkill you, *Pyrophilus*, have found very good effect in your ſelf, and who was one of the two profeſſors, that writ the *Philoſophia naturalis reformata*, had a very famous remedy (which now he is dead, I intend, God willing, to communicate) againſt the ſtone; and with it he told me, that he had very often cured that diſeaſe in the kidneys: but for the ſtone in the bladder, he thought it impoſſible to be diſſolved; which circumſtances I recite, that you may the more readily believe what he told me a little before his death; namely, that he had cured lately one Mr. *Moulin* of a real ſtone in the bladder; adding, that he could not brag of being the inventor of that remedy he had employed, having but lately learned it of a country gentleman, whom going to viſit laſt ſummer, he ſaw a load of *Perſicaria*, or arſmart, brought to him by ſome of the country people; and deſiring to know what he intended to do with ſo vaſt a quantity of it, the gentleman replied, that he yearly uſed as much, having by the water of it, made by bare diſtillation in a common roſe-water ſtill, cured ſo many of the ſtone, even in the bladder, that he was uſually ſollicited by patients, numerous enough, to exhauſt all the liquor which he yearly prepared.

The uſe of Perſicaria for that cure.

WHAT we, *Pyrophilus*, have obſerved concerning this excellent liquor, of which we uſe to preſcribe a draught every morning for ſome months together, we may elſewhere have occaſion to relate. But now we ſhall go on to tell you, that being ſome years ſince in *Ireland*, I met with an ancient empirick, who was very famous in thoſe parts for cutting of the ſtone of the bladder, and for curing ſore eyes. This man having given (in the parts where I then was, and whilſt I was there) ſome good proof of his ſkill, I ſent for him to me, upon the account of a ſuſpicion I long had of the ſtone in the bladder; which, upon ſearch, he aſſured me I was free from, and ſo (God be praiſed) I have afterwards found it. He was more a traveller than a ſcholar, and yet finding him, to my wonder, very modeſt and ſober, I inquired of him, whether he had never any where met with a remedy, that could diſſolve the ſtone in the bladder, offering him much more for a cure of that kind, than he would require as a lithotomiſt. He anſwered me, that he could cure no man of a confirmed ſtone, but by the help of his knife; but if the ſtone conſiſted of a lump of gravel not very firmly cemented together, he had, by a certain inward remedy he uſed, and a dexterous way of cruſhing the ſtone from without with his fingers, ſo broken the ſtone, partly by crumbling it, and partly by diſſolving the cement, as to make it avoidable by urine. And he added, that he had formerly cured a citizen of *Cork*, of a good large ſtone of the bladder, (for where I then was, he gave a proof of his ſkill, in telling before-hand thoſe he was to cut, the bigneſs and ſhape of the ſtones, that troubled them.)

Inſtances in other happy medicines for the ſame diſeaſe.

PASSING afterwards by *Cork*, I ſent an intelligent ſervant to inquire after this citizen; but, he being caſually abſent, his wife ſent me, by my man, a relation very agreable to that, which he had made me. The receipt I purchaſed of him, and though it ſeem not very artificial, yet I ſuppoſe you will not quarrel with me, for annexing ſo experienced a one, to the end of this eſſay. But becauſe this remedy needed the aſſiſtance of a manual operation, we ſhall further proceed to tell you, that *Cardan*, as he is quoted by *Helmont* (for I have not now his works by me) relates, that in his time there rambled a man over *Lombardy*, who did commonly, and in a few days, by a certain liquor which he adminiſtred to his patients, ſafely, ſpeedily, and certainly, cure thoſe, that were troubled with the ſtone in the bladder: adding (ſaith *Helmont*) his judgment, that he doubted not of this man's being in hell, for having, when he died, envied mortals ſo excellent an art.

De lith. c. 7. num. 14.

I INSIST not on the teſtimony, that the ſame *Helmont* gives to *Paracelſus* of his curing the ſtone, though he often handle him very ſevere-

ly in other places of his writings, becauſe that the epitaph of *Paracelſus* (out of which he labours to prove his having cured the ſtone) makes no expreſs mention of it. Nor ſhall I enumerate thoſe paſſages, from whence the ſame *Helmont*'s followers collect, that he himſelf was able to cure that diſeaſe, by the reſolution of *Paracelſus* his *Ludus*; but this experience hath evinced to me, that a much ſlighter preparation of that ſtone, than was mentioned by *Paracelſus* and *Helmont*, hath been able to do more in that diſeaſe, than a wary man would readily believe. But to detain you no longer on this ſubject, I ſhall only add, that *Wilhelmus Laurembergius*, a learned phyſician, and profeſſor at *Roſtoch*, hath told the world, how he cured himſelf of a confirmed ſtone of the bladder, by the uſe of prepared millepedes (by ſome in *England* called wood-lice) and other remedies, which he hath particularly recorded in the hiſtory, which he hath publiſhed, and I have ſeen of this admirable cure; which having been epitomized by *Sennertus*, and other eminent phyſicians, I ſhall not need to inſiſt on it. And the arguments alledged (even by the moſt judicious) againſt the cureableneſs of the ſtone, though very plauſible, ſeem not to me unanſwerable; for whereas firſt they appeal to the innumerable fruitleſs attempts, that have been made to cure great princes, and rich men, without cutting, that argument drawn from experience may, by the former experiments, be anſwered, eſpecially ſince *Horatius Augenius* (upon whoſe account *Laurembergius* tried millepedes) tells us, not only that he cured a young man at *Rome*, that was going to be cut of the ſtone, but that the Jeſuit, that chanced to confeſs this youth, and perſuaded him to the uſe of millepedes, had experimented their efficacy both upon himſelf and others. And indeed we our ſelves have found them to be highly diuretick and aperitive.

The uſe and ſucceſs of millepedes.

AND whereas it is next objected, that medicines muſt neceſſarily loſe their efficacy before they can reach the bladder, I confeſs, that for the moſt part, it is very true; but yet that it is poſſible for ſome medicines to retain their nature, after many alterations and digeſtions, we have elſewhere declared. And in our preſent caſe, we not only find, that turpentine and aſparagus do manifeſtly affect the urine (as I have often obſerved in my own, and almoſt any man may obſerve it in his;) but that which is moſt to our purpoſe, rhubarb tinges the urine of thoſe, that have taken any quantity of it. And laſtly, whereas it may be yet further alledged, that not only there hath not been yet a liquor found capable of diſſolving ſo ſolid a body as a ſtone; but, if there were, it muſt neceſſarily be ſo corroſive as to deſtroy the patient, by fretting his ſtomach, or guts, or bladder, which are parts ſo much more tender: to the firſt part of this plauſible objection it may be replied, that even good vinegar will diſſolve not only thoſe ſtony concretions, called *lapides cancrorum*, which, like the *calculi* we treat of, are formed in the bodies of animals, but even the more hard and ſolid body of coral, which will loſe but little of its weight, in a fire, that would waſte a great part of the *Duelech:* and that the bare juices of vegetables (ſuch as lemmons and barberries) will readily diſſolve both pearl and coral, is known even to the apothecaries boys. Indeed, what *Paracelſus* and *Helmont* relate of their alkaheſt, with which they prepare their ſpecifick againſt the ſtone, and with which the latter of them, if not both, pretend to be able to reduce, not only the ſtone they call *ludus*, but all other ſtones, vegetables, minerals, animals, *&c.* into inſipid water, is ſo ſtrange (not to ſay incredible) that their followers muſt pardon me, if I be not forward to believe ſuch unlikely things, till ſufficient experience hath convinced me of their truth.

The argument, concerning the incureableneſs of the ſtone, anſwered.

BUT yet I muſt not conceal from you, that a chymiſt, whom you have often ſeen, adviſed with me ſeveral times about the way of preparing this immortal liquor (as *Helmont* calls it) and that, when we had agreed, that ſuch a way was the moſt promiſing, he proſecuted it ſo long, and ſo induſtriouſly, that at length he obtained, and ſhewed me a liquor, which (though it ſeemed to me far ſhort of the alkaheſt) I confeſs I admired; and not I alone; but our ingenious friend Dr. *C.* (who had been imployed into ſeveral parts of *Europe*, by a rich and curious princeſs, to purchaſe rarities) agreed with this chymiſt, to give two hundred crowns for a pint of this menſtruum; and confeſſed to me withall, that he ſaw him, with this liquor, not only diſſolve common ſulphur, and bring it over the helm, but reduce antimony into ſweet cryſtals: with a few of which it was, that he (I mean Dr. *C.*) to the wonder of many, did, without purge or vomit, cure our good friend Sir *C. C.* of a very radicated and deſperate diſeaſe, as the reſtored patient ſoon after told me. And to the ſecond part of this objection it may be anſwered, that if we knew and conſidered well, how many of the operations of natural bodies depend upon the ſuitableneſs and difference of the figures of their parts, and the pores intercepted between them, the number of impoſſibilities would not, perhaps, be thought ſo great, as by many learned men it is.

That there may be a liquor able to diſſolve the ſtone, that may not be corroſive to any other part.

THAT it is very poſſible for a body to have an effect upon another determinate body, without being able to operate in like manner upon a multitude of other bodies, which may ſeem more eaſy to be wrought on by it; may appear by the loadſtone, which will draw and work only upon iron, and (which is but refined iron) ſteel, but not upon wood, or ſtraws, or any of thoſe innumerable concretes, that are lighter, and of a more open texture, than the heavy and ſolid body, which it attracts. And to give you an inſtance, that comes nearer to our caſe, quickſilver, that will not corrode our ſkin, nor ſo much as taſte ſharp upon our tongue, will yet readily diſſolve that moſt compact body of gold, which even aqua fortis, that can inſinuate it ſelf into all other metals, and corrode them, will not meddle with; though the ſame quickſilver will not diſſolve iron, which yet aqua fortis will very nimbly fret aſunder. So that, although I dare not confidently believe all,

all, that I have found averred, even by eminent and learned chymiſts, of their having made or ſeen liquors, which, without appearing any way ſharp to the tongue, would diſſolve gold and ſilver, and other hard compact bodies; becauſe I have not yet my ſelf ſeen any ſevere and ſatisfactory trial made to evince the efficacy of inſipid diſſolvents: yet, by reaſon of divers things I have read and heard, and of ſome things too I have ſeen, I dare not peremptorily deny the poſſibility of ſuch menſtruums. And who knows, but that in nature there may be found, or by art there may be prepared, ſome liquor, whoſe parts may have ſuch a ſuitableneſs to the pores of a human *calculus*, as thoſe of quickſilver have to the pores of gold; and yet may as little work upon the reſt of the body, as we have obſerved the ſame quickſilver to do upon iron, (which yet is a much more porous and open metal) even when it hath been diſtilled in iron veſſels? And as to that part of the objection, wherein the ſtrength of it chiefly lies, let me tell you, *Pyrophilus*, that I have ſometimes, for curioſity's ſake, taken an egg, and ſteeped it in ſtrong vinegar for ſome days, and by taking it out, and ſhewing, that the ſhell was ſo eaten away, that the egg could be ſqueezed into unuſual forms, but the thin ſkin, that involves the white, continued altogether unfretted, I convinced an ingenious man, that the operation of diſſolvents are ſo determined by the various textures of bodies, on which they are employed, that a liquor, which is capable to corrode a more hard and ſolid body, may be unable to fret in the leaſt another more ſoft and thin, if of a texture indiſpoſed to admit the ſmall parts of the menſtruum. And I muſt confeſs to you, *Pyrophilus*, that one thing, among others, which hath made me backward to affirm with many learned men, that there can be no potent diſſolvent, that is not corroſive enough to fret in pieces the parts of a human body, hath been a ſtory, which I divers years ſince, chanced to meet with in the learned *Sennertus*'s *Paralipomena*, where, though he relates it to another purpoſe, yet it is ſo pertinent to our preſent deſign, and in it ſelf ſo ſingular, not to ſay matchleſs, that I cannot forbear to mention it here on this occaſion. He tells us then, that in the end of the year 1632, *Johannes Neſterus*, an eminent phyſician, and his great friend, informed him, that there lived at that time in the neighbourhood, and belonging to a nobleman of thoſe parts, a certain Lorrainer, whom he alſo called *Claudius*, ſomewhat low and ſlender, and about 58 years of age: *Hic* (ſaith he) *nihil foetidum, nihil injucundum abhorret; vitra, lapides, ligna, carbones, oſſa, leporinos & aliorum animalium pedes cum pilis, lineos, laneoſque pannos, viva animalia, & piſces adhuc ſalientes, imò etiam metalla, patinas & orbes ſtanneos dentibus confringere & vorare ſæpiſſimè viſus eſt. Vorat præterea lutum, ſevum & candelas ſebaceas, integras teſtes cochlearum, animalium ſtercora, cum primis bubulum calidum adhuc, prout è matre venit: potat aliorum urinas cum vino & cereviſia mixtas. Vorat fœnum, ſtramen, ſtipulas, & nuper duos mures viventes adhuc deglutivit, qui ipſius ventriculum ad ſemihoram uſque creberrimis morſibus lancinarunt; &, ut brevibus complectar, quicquid illi à nobilibus devorandum offertur, viliſſimâ mercede propoſitâ, dictum ac factum, ingurgitat, ita ut intra paucos dies integrum vitulum crudum & incoctum cum corio, & pilis ſe eſtaturum promiſerit. Teſtes inter alios quamplurimos ipſe ego ſum, quippe qui, &c.* 'He loaths nothing 'that ſtinks, or is otherwiſe unpleaſant. He 'hath been often ſeen to chew and ſwallow 'glaſs, ſtones, wood, bones, the feet of hares, 'and other animals, together with the hair; 'linnen, and woollen cloth; fiſhes, and other 'animals alive; nay, even metals, and diſhes, 'and globes of tin: beſides which, he devours 'ſewet, and tallow-candles, the ſhells of 'cockles, and the dungs of animals, eſpecially 'of oxen, even hot, as ſoon as it is voided. 'He drinks the urine of others mixt with 'wine or beer; he eats hay, ſtraw, ſtubble, 'and lately he ſwallowed down two living mice, 'which for half an hour continued biting at 'the bottom of his ſtomach; and, to be ſhort, 'whatſoever is offered him by any noble perſons, it goes down with him without more 'ado upon the ſmalleſt reward, inſomuch that 'within a few days he hath promiſed to eat 'a whole calf raw, together with the ſkin 'and hair. Among divers others, I my ſelf am 'a witneſs of the truth of theſe, &c.' To this and the following part of the letter, *Sennertus* adds, that not having, during ſome years, heard any thing concerning this *Claudius*, he ſent about four years after to the ſame phyſician, Dr. *Neſterus*, to enquire what was become of him; and that the doctor ſent him back a letter of the miniſter of the church of that place, by way of confirmation of all the formerly mentioned particulars, and anſwered himſelf, that the Lorrainer, whom he had long hoped to diſſect, was yet alive, and did yet devour all the things mentioned in his former letter, but not ſo frequently as before; his teeth being grown ſomewhat blunter by age, that he was no longer able to break bones and metals. Some other examples of this nature, though none ſo ſtrange, we have alſo met with in writers of good credit, and eſpecially that of the glaſs-eater, recorded by *Columbus* in his excellent anatomical obſervations; of which alſo *Sennertus* makes mention, as we ſhall ſee by and by, and with which we may elſewhere entertain you to another purpoſe. And not long ago there was here in *England* a private ſoldier (who, for aught I know, is yet alive) very famous for digeſting of ſtones. And a very inquiſitive man, that gave me the accurateſt account I have met with concerning him, aſſures me, that he knew him familiarly, and had the curioſity to keep in his company for twenty-four hours together to watch him, and not only obſerved, that he eat nothing in that time, ſave ſtones (or fragments of them) of a pretty bigneſs, but that his groſs excrement conſiſted chiefly of a ſandy ſubſtance, as if the devoured ſtones had been in his body diſſolved and crumbled into ſand. But let us not omit, that to the ſecond epiſtle above mentioned *Sennertus* adds this reflection, not impertinent

Examples of thoſe, who could digeſt metals and glaſs.

Medicus Rochlizenſis.

to

to our purpoſe: *Cauſam* (ſays he) *hujus voracitatis, etiam in cadavere, invenire proculdubio erit difficillimum. Poſſet quidem ad illud, quod in cadavere Lazari vitrivoracis obſervavit Columbus, quidam confugere; & ſtatuere quartam illam nervorum conjugationem, quæ guſtus gratia in hominibus à natura producta eſt; neque ad palatum, neque ad linguam pertendere. Verum hoc modo ſaltem guſtus aboliti cauſa redderetur, nondum verò cauſa daretur, cur res tam miras aſſumere ſine ventriculi læſione, imò concoquere potuerit. Quæ proculdubio in ἰδιοσυγκρασίᾳ & peculiari conſtitutione ventriculi & inteſtinorum quærenda eſſet; quæ tamen oculis inveſtigari non poteſt, ſed ſaltem ex effectu patet:* 'To find in the 'carcaſs the cauſe of this voracity, will be, 'queſtionleſs, very difficult. Some one per-'chance would refer it to that, which *Columbus* 'obſerved in the carcaſs of *Lazarus* the glaſs-'eater, and reſolve, that the fourth conjugation 'of nerves, which nature ordained for taſting, 'comes neither to the palate, nor the tongue: 'but ſo there would only be rendered the cauſe 'of this want of taſte, and not why he ſhould 'be able to take ſuch uncouth things, without 'offence to his ſtomach, and digeſt them, which 'without doubt ought to be the particular and 'ſingular conſtitution of his ſtomach and guts, 'which yet may not appear to the eye by the 'effects.' And indeed this memorable ſtory ſeems to argue, not only what we have already alledged it to prove, but alſo that a menſtruum not ſo corroſive as to fret the body, may diſſolve ſtones, metals, and other compact ſubſtances. And ſince one liquor, prepared by nature only, could in this man's ſtomach diſſolve that great variety of bodies above enumerated, why ſhould it be thought, that the alkaheſt, or ſome other menſtruum, wherein nature is ſkilfully aſſiſted, and to the utmoſt heightened by art, ſhould not be able to diſſolve concretes of very differing textures? For though chymiſts muſt acknowledge, that ſuch common menſtruums, as will diſſolve one body, will not oftentimes meddle with another; as aqua fortis will diſſolve ſilver, and not gold; and if by ſal armoniac you turn it into aqua regis, it will indeed diſſolve gold, but then it will not ſilver: yet ſince that may be ſuppoſed to proceed rather from our want of ſkill to prepare the moſt potent menſtruum, than from the impoſſibility of one menſtruum's diſſolving great variety of bodies; why may not nature and art afford a menſtruum, whoſe variety of parts and figures, and, perhaps alſo, motion, may give it ingreſs into bodies of very differing textures? as in our former inſtance, though aqua regalis will diſſolve gold, not ſilver, and aqua fortis ſilver, but not gold, yet quickſilver will diſſolve both, and copper, tin, and lead to boot.

IF I were not at preſent under ſome reſtraint, I might tell you ſome things, that you would, perhaps, think no weak confirmations of the paſt diſcourſe. And however, ſince I have obſerved it to be the main thing, that keeps judicious men from ſeeking, or ſo much as hoping for nobler diſſolvents, that they are ſcarce to be perſuaded there can be conſiderably piercing menſtruums, that are not ſo proportionably corroſive; I will here acquaint you with a liquor, that may, I preſume, aſſiſt you to undeceive ſome of them. We take then ordinary houſhold brown bread (I like that of rye, but I have divers times uſed that of wheat) and when it is cut into ſlices, and ſomewhat dried, we almoſt fill a glaſs retort with it, and placing that in a ſand-furnace, by degrees of fire we draw off what will be made to come over, without much difficulty. The oil, as uſeleſs to our purpoſe, being by a tunnel, or a filter, ſever'd from the reſt of the liquor, we alſo, by a gentle heat, free the ſpirit from ſome of its phlegm, which yet ſometimes we find no great neceſſity to do. And yet this ſpirit, which you will eaſily believe is no ſuch corroſive as aqua fortis, or other diſtilled liquors of mineral ſalts, will work upon the hardeſt ſorts of bodies, and perform things that chymiſts, counted of the judiciouſeſt, would not have us expect from the moſt ſharp and corroſive menſtruums now in uſe. For with this we have, in a ſhort time, and that in the cold, drawn tinctures (which is done by the ſolution of the finer parts of the concrete) not only from crude corals, and ſome of the more open minerals, but likewiſe from very hard ſtones, ſuch as blood-ſtone, and granates, (even unpowdered.) Nay, and though rubies ſeem to be the hardeſt bodies yet known, ſave diamonds, (for I have learned from thoſe, that cut precious ſtones, that they can grind other gems with the powder of rubies, but not theſe with any powder, ſave their own, and that of diamonds;) yet have even theſe afforded me, in the cold, a not ignoble tincture. And not to anticipate what I may elſewhere have occaſion to tell you concerning the efficacy of this menſtruum, which is the ſame, that I have intimated, without naming it, in the laſt and another of the former eſſays; I ſhall now only add, that an expert chymiſt aſſures me he hath, but tells me not how, done greater matters with it, or the like; and that to ſatiſfy my ſelf, that theſe high tinctures proceeded not from the ſtanding or digeſtion of the menſtruum (as we elſewhere obſerve concerning ſome other liquors) I not only tried, that from ſome minerals it will draw a much higher tincture than from others, and from ſome ſcarce any at all; but that it would, if kept by it ſelf, for many months continue clear and limpid. What further uſe I have made, or think others may make of this odd menſtruum, I muſt not, as I ſaid, at preſent expreſs; but returning to what I was diſcourſing concerning the cure of the ſtone, annex, that beſides what hath been objected againſt the poſſibility of making a liquor, which, without being highly corroſive, can be able to work upon ſtone; it may indeed be alſo alledged againſt the hopes we ſeem to countenance, that what hath cured the ſtone in one man's bladder, may be unable to do the like in another's. But firſt, the truth of that hath not been proved; and next, we highly value thoſe ſpecificks, that can remove agues, fluxes, and the like diſeaſes; though ſcarce any of them

The deſcription of a menſtruum, prepared from a common bread, able to draw tinctures from precious ſtones, minerals, &c.

them do alike ſucceed in all patients, eſpecially ſo as to ſecure them during their whole lives, from ever relapſing into the like diſeaſe; and beſides all this, it will be no ſmall matter to find, that the diſeaſe, in its own nature, is not incurable; and it would recompenſe men's induſtry to be able to free, even a few patients, from to painful and ſtubborn a diſeaſe. Which I have rather than any other, choſen to inſiſt upon, becauſe it is ſo generally believed not to be curable by inward remedies in any perſon whatever.

Helmont's argument from the providence of God cenſured.

BUT I have entertained you ſo long on this ſubject, that I muſt reſerve, for ſome other opportunity, what I have to ſay to you concerning the dropſy, and ſome other diſeaſes, commonly put into the catalogue of the incurable ones; and therefore ſhall now only tell you in general, that as on the one ſide I think the arguments, which *Helmont* and others draw from the providence of God, for the curableneſs of all diſeaſes, are not very cogent, and ſomewhat irreverent, (for God being not obliged any more to continue life or health to ſinful man, than to beaſts, that never offended him, we ought humbly to thank him, if he hath, among his creatures, diſperſed remedies for every diſeaſe, but have no right to accuſe him if he have not;) ſo on the other ſide, I am not much convinced by the grand argument alledged againſt *Paracelſus*, and the chymiſts, that hold all diſeaſes to be in their own nature curable, namely, that they themſelves many of them, (no nor even their very maſter) lived not to the age attained by many ſtrangers to chymiſtry.

The argument, that Paracelſus *outlived not the 47th year of his age, anſwered.*

FOR this, that many of them (not deſtroyed by war, or outward accidents) died young enough, and conſequently by ſickneſs, and that *Paracelſus* himſelf out-lived not the 47th year of his age, is a much ſtronger objection againſt the men, than againſt their opinion; for it infers indeed plauſibly, that they had not ſuch remedies as they boaſted of, (ſince probably, had they had any ſuch, they would have cured themſelves with them;) but concludes not, that no ſuch remedies can be prepared by any other. And this you will be the leſs apt to think irrational, if you conſider, how much more learned, ſober, and experienced it is poſſible for many a man to be, than *Paracelſus* appears to have been. For he ſeems not, by his writings, to have been any great logician or reaſoner; he manifeſtly deſpiſed many parts of learning uſeful to a phyſician; he lived not many years, and ſpent divers of thoſe few, which he lived, in an unſettled and diſadvantageous courſe of life; and yet this *Paracelſus* attained to ſome ſuch remedies, as both in his own and after-times have made him a very conſiderable perſon, in ſpight of all his indiſcretions and deficiencies. And among his other remedies, his famous *laudanum* did ſuch wonders, that *Oporinus* himſelf, in that ſhort account, which ſeems to be rather a ſatyr than a narrative of his life, hath this paſſage of it:

The efficacy of Paracelſus's laudanum

De laudano (ſaith he) *ſuo (ita vocabat pilulas inſtar murium ſtercoris, quas impari ſemper numero, in extrema tantùm morborum difficultate tanquam ſacram medicinam exhibebat) ita gloriebatur, ut non dubitarit affirmare ejus ſolius uſu ſe è mortuis vivos reddere poſſe; idque aliquoties, dum apud ipſum fui, re ipſa declaravit:* 'Of his *laudanum* (that name he gave 'to little pills, which in the extremity of diſ-'eaſes he adminiſtered as a moſt divine medi-'cine, always giving them in an odd number) 'he ſcrupled not to affirm, that by that medi-'cine he could put life into thoſe, who were 'as good as dead; and that while I was with 'him, he made good in ſome experiments. So ſignal a teſtimony coming from one, whom the Paracelſians call his fugitive ſervant, hired by his enemies to ſlander him under pretence of writing his life, deſerves not to be ſlighted: and though it manifeſtly contains an hyperbole, yet I do the leſs wonder at the hyperbole, by reaſon of thoſe ſtrange things, which your mother, and divers other of your friends, can tell you, they have ſeen performed in *England* by *Helmont*'s *laudanum opiatum*, (though much inferior to that of *Paracelſus*.) And I remember, that a friend of yours and mine, that is a great enemy to all kinds of chymical remedies, and was before alſo to chymiſtry, having begged of me a little bottle of it, which I had obtained from a friend of the younger *Helmont*'s, to whom he communicated the preparation, gave me a while after an account of ſuch cures, that had been performed, with that ſmall quantity, upon almoſt dying perſons, as I think it not diſcreet for me, that was not an eye-witneſs of them, to relate. And I remember too, that the ſame friend of young *Helmont*'s, being, at the perſuaſion of one woman, whom he had cured of a dangerous conſumption, called to another, that was thought to be dying of an aſthma, came to adviſe with me, whether he ſhould meddle with ſo deſperate a patient; telling me, that ſhe had been many years ſick of that ſtubborn diſeaſe, which, in proceſs of time, paſſing into an orthopnea, had at laſt put her, by want of ſleep (from which the violence of her ſickneſs had very long kept her) into a fever, and ſo deſperate a condition, that it was ſcarce expected ſhe ſhould live till the next morning. But I repreſenting to him, that her condition being avowedly deſperate, he might exerciſe his charity without danger to his reputation; and perſuading him to try *Helmont*'s *laudanum*, together with the ſpirit of man's blood (which we elſewhere teach you to prepare) he gave her that night a doſe of thoſe remedies, which made her both ſleep and breathe pretty freely; and a week after, he coming to viſit me, told me, he had caſually met his patient well and abroad in the ſtreets. But theſe are trifles to the cures, which *Helmont* relates to have been performed by our Iriſh *Butler:* for he tells us, that this man, by ſlightly plunging a little ſtone, he had, into almond-milk or oil, imbued thoſe liquors with ſuch a ſanative efficacy, that a ſpoonful of the former cured (and that without acquainting him with what was given him) a Franciſcan frier (a very famous preacher) of a very dangerous eryſipelas in the arm, in one hour; and one drop of the latter being

Butler's great remedies.

Helmont *in the treatiſe, which he entitles* Butler.

applied

applied in his preſence, to the head of an old laundreſs, that had been ſixteen years troubled with an intolerable hemicrania, the woman was preſently cured, and remained ſo to his knowledge for divers years. He adds almoſt as ſtrange a cure done in one night, upon a maid of his wife's, by anointing the part affected with four drops of that oil. He farther tells us, that the maſter of the glaſs-houſe at *Antwerp*, being troubled and made unwieldy with too much fat, begged ſome relief of *Butler*; who, having given him a little fragment of his little ſtone, with order to lick it nimbly with the tip of his tongue once every morning, I ſaw, ſaith *Helmont*, within three weeks, the compaſs of his waiſt leſſened by a ſpan, without any prejudice to his health. And to theſe, *Pyrophilus*, he adds ſome other narratives, which, though I confeſs I know not well how to believe, yet there are circumſtances, which keep me from daring to reject them. For firſt, as he well obſerves, that, which was moſt ſtupendous in this remedy, was but the ſmallneſs of the quantity. Next, a gentleman in *France* being not long ſince reported to have a fragment of this ſtone, and to have cured ſeveral perſons (and eſpecially one very dignified) of inveterate diſeaſes, by letting them lick it; my noble friend Sir *Kenelm Digby*, then in *France*, was ſolemnly requeſted from hence to inquire into the truth of that report, and anſwered, that he could not, upon examination, find it other than true. Beſides, *Helmont* not only relates theſe cures as an eye-witneſs of them, but tells us, how upon an occaſion, that he mentions, he once ſuſpected the efficacy of the oil; and that, without expecting, that it ſhould do any thing, he anointed it on the right arm and the ancles of his own wife, who had for ſome months been tormented with great pains in the former, and very great tumours in the latter of thoſe parts; and that, almoſt in a trice, motion was reſtored to her arm, and all the *œdema* of her legs and feet vaniſhed; adding, that at the time of his writing ſhe lived healthfully, and had done ſo ſince that recovery, during nineteen years. And this ſtory ſhe, long after her huſband's death, confirmed to our ingenious friend Dr. *C.* who is acquainted with her, and much extols her. Theſe circumſtances may be aſſiſted by two more very conſiderable ones; the one is, that *Helmont* is the more to be credited in theſe relations, becauſe mentioning cures not performed by himſelf, but by others, and that by remedies unknown to him, he ſeems by theſe narrations, out of loyalty to truth, to eclipſe his own reputation: and the other is, that in a memorable ſtory, which we may elſewhere relate to you (being not here proper to inſert ſo long a one) you'll find an eminent and ſtrange teſtimony given to *Butler*'s ſecrets, by our famous countryman Dr. *Higgins*, whoſe confeſſion you will not doubt, if you conſider how rare a phyſician and chymiſt he was, how familiarly he lived in the ſame houſe with *Butler*, and how ſtudiouſly at laſt they endeavoured to take away each other's life.

BUT whatever be to be thought, *Pyrophilus*, of *Helmont's* relation, we may well enough make this reflection on the other things, that have been delivered concerning formidable diſeaſes, that ſince the power of nature and ſkill may reach much farther than many diſtruſtful (not to ſay lazy) men have imagined, it will not be charitable to rely too much upon the prognoſticks, even of famous writers, when they tell us, that ſuch and ſuch diſeaſes, or patients in ſuch and ſuch conditions cannot poſſibly be cured: but rather to follow the ſober counſel of *Celſus*, *Oportet* (ſaith he) *ubi aliquid non reſpondet, non tanti putare authorem quanti agrum, & experiri aliud atque aliud.* 'Where a medicine anſwers not, we ought not ſo much to eſteem the author as the patient, and to try ſomewhat farther and farther.' And this great phyſician's authority I therefore make the moſt uſe of in the enſuing eſſays, becauſe he is accounted very judicious by the Lord *Verulam*, and other writers, that are unqueſtionably ſo themſelves. *De medicina*, lib. 3. cap. 10.

ESSAY IV.

Preſenting ſome things relating to the Hygieinal part of Phyſick.

THAT the dietetical part of phyſick, *Pyrophilus*, may as well as the others, be improved by natural philoſophy, were not uneaſy to manifeſt, if my haſte would permit it: for it is known, that drinks make a very conſiderable part (ſometimes, perchance, amounting almoſt to the one half) of our aliments; and moſt drinks, as wine, beer, ale, mead, *&c.* conſiſt of fermented liquors. Now as on the one ſide the ignorance of the doctrine of fermentation, and of the wholeſome way of both preſerving liquors and making them pleaſant, doth queſtionleſs occaſion more than a few diſeaſes, which in divers places may be obſerved evidently to proceed from the unwholeſome quality of either ill-made or ſophiſticated drinks; ſo, on the other ſide, the diſtinct knowledge of the true nature and particular phænomena of fermentation would enable men to prepare a great variety of drinks, not only as harmleſs, but as beneficial as pleaſant. *That the knowledge of fermentation is uſeful to make our drinks wholeſome for aliment.*

How much preparation may do to correct and meliorate both hard and liquid aliments,

is notably inſtanced by the account, that we receive from both the French and Engliſh that inhabit the *Barbados*, *St. Chriſtophers*, and other *Caribbee* iſlands, who ſolemny inform us (what is atteſted alſo by *Piſo*, and other learned travellers, that write of it) that the plant mandioca (whoſe prepared root makes caſſavy, and which we have alſo ſeen flouriſhing here in *Europe*) to which the Indians are ſo much beholden, is a rank poiſon. And though I ſhall tell you, that having purpoſely inquired of a very intelligent gentleman, who commanded an army of Europeans in *America*, what experience he had ſeen of the qualities of this plant, he told me, that between thirty and forty of his ſoldiers, having on a time (whilſt they were unacquainted with the country) either through ignorance or curioſity, eaten of it unprepared, it coſt moſt of them their lives. And yet this pernicious root, which ſome herbariſts call *yucca*, by the rude Indians ordering, comes to afford them both almoſt all their bread, and no ſmall part of their drink. For this root being grated, and carefully freed from its moiſture, by being included in bags, and very ſtrongly preſſed, till all the juice be ſqueezed out, it is afterwards dried in the ſun, and ſo made into meal, of which they make their bread. And this very root, though (as we ſaid) it be poiſonous, they cauſe their old and almoſt toothleſs women, for the better breaking and macerating it, to chew and ſpit out into water. This juice will, in a few hours, work and purge itſelf of the poiſonous quality, affording them a drink which they eſteem very wholeſome, and at the *Barbados* call *perino*, and account it to be the likeſt in taſte to our Engliſh beer, of any of thoſe many drinks, that are uſed in that iſland.

How much ſimples may be altered by preparation, exemplified by the Indians making Caſſavi *out of the poiſonous plant* Mandioca

Odd unhandſome ways of their making drink from the ſame root.

Hiſtory of the Barbados, pag. 29, 30, 31, 32.

THIS naſty way of preparing drink, *Pyrophilus*, may ſeem ſtrange to you, as it did to me, when I firſt heard of it; but beſides the conſenting relations both of French and Engliſh concerning it, it may be confirmed by the ſtrange aſſertion of *Gulielmus Piſo*, in his new and curious *Medicina Braſilienſis*, where, having ſpoken of ſeveral of the Braſilian wines, he tells us, that they make liquors of ſeveral plants beſides the root of mandioca, after the ſame naſty manner. *Idem fit* (ſaith he) *ex mandioca, patata, milio Turcico, oryza, & aliis, quæ à vetulis maſticantur, maſticataque multa cùm ſaliva exſpuuntur; hic liquor mox vaſis reconditur, donec ferveat, fæceſque ejiciat.* 'The ſame is made of mandioca, potatoe's, 'Turkiſh millet, rice, and other things, which 'being chewed by old women, and ſpit together 'with much ſpittle, this liquor is ſtrait put 'up into veſſels, and there kept, until it fer'ments and caſts down a ſediment.'

Voyage de Muſcovie & de Perſe, p. m. 23.

IN *Muſcovia* itſelf, notwithſtanding the unſkilfulneſs of that rude people, *Olearius* informs us, that the embaſſadors, to whom he was ſecretary, were preſented at one time with two and twenty ſeveral ſorts of drink. And at a country-houſe here in *England* (where I was, by a very ingenious gentleman, that is maſter of it, preſented with divers rare drinks of his own making) I was aſſured, that he had lately, at one time in his houſe, at leaſt the former mentioned number of various drinks, and might eaſily have had a greater, if he had pleaſed.

Of making drink from ſorts of coarſe bread.

AND on this occaſion, I am not willing to pretermit what is practiſed in ſome of our American plantations, as I am informed by the practiſers themſelves; where, finding it very difficult to make good malt of maiz, or Indian corn, (by reaſon of hindrances not to be diſcourſed of in few words) they brew very good drink of it, by firſt bringing the grain to bread; in which operation, the grain being both reduced into ſmall parts, and already ſomewhat fermented, is diſpoſed to communicate eaſily its diſſoluble and ſpirituous parts to the water it is boiled in. To which I ſhall add, that I have reaſon to think, that the art of malting may be much improved by new and ſkilfully contrived furnaces, and a rational management of the grain.

NOR are we alone defective in the knowledge of fermenting drinks, but even in that of the materials, of which drinks may be prepared.

The drinks in uſe in China.

IN that vaſt region of *China*, which is enriched with ſo fertile a ſoil, and comprizeth ſuch variety of geographical parallels, they make not (as *Semedo* informs us) their wine of grapes, but of barley; and, in the northern parts, of rice, where they make it alſo of apples: but in the ſouthern parts, of rice only; yet not of ordinary rice, but of a certain kind peculiar to them, which ſerves only to make this liquor, being uſed in divers manners. And of the wine there drank, even by the vulgar, our author gives us this character: The wine uſed by the common people, although it will make them drunk, is not very ſtrong or laſting; it is made at all times of the year, but the beſt only in the winter: it hath a colour very pleaſing to the ſight, nor is the ſmell leſs pleaſing to the ſcent, or the ſavour thereof to the taſte; take all together, it is a vehement occaſion, that there never wants drunkards, *&c.* And of the inhabitants of the kingdom of *Japan*, I remember alſo, *Pyrophilus*, that *Linſchoten*, in his deſcription of thoſe iſlands, tells us, that they drink wine of rice, wherewith they drink themſelves drunk.

Hiſtory of China, part. 1. c. 1.

Linſchoten's *voyages*, book 1. c. 26.

Of cherry wine.

WE have here in *England*, at the houſe of our experienced mint-maſter, Dr. *Gordon*, taſted a wine, which he made of that ſort of cherries which are commonly called morello, that was, when we drank of it, about a year and a half old, but it was ſomewhat ſour, and needed ſugar. And therefore I ſhall rather take notice to you of my having ſince drank wine made of the juice of good, but not of extraordinary Kentiſh cherries, which, with the help of a *tantillum* of ſugar added in the fermentation, kept ſo well, that though it were above a year old when I taſted it, I found it a ſtrong and pleaſant wine, not inferiour to many wines, that are brought us from foreign parts. But this is nothing to what is averred upon his own experience, by a learned divine (to whom you, *Pyrophilus*, and I, am related) who affirms himſelf to have made out of ſome

Of excellent cyders. ſort of wild apples and pears, by bare fermentation, ſuch liquors, as though at firſt ſomewhat harſh, will not only keep divers years, but, at the end of two or three, attain ſuch ſtrength, and ſo pleaſingly pungent a taſte, that they may compare even with choice outlandiſh wines, and excel thoſe, that are not of the very beſt ſorts of them.

BUT till we have in another eſſay an opportunity of preſenting you ſomething out of the obſervations of *Olearius*, the newly mentioned divine, and our own, concerning fermented liquors, we ſhall content our ſelves to manifeſt our want of curioſity about the materials, of which drinks may be prepared, by this, that the drinks of one whole country are oftentimes unknown to the inhabitants of another. That the wine made of rice, which we lately mentioned to be of frequent uſe in the kingdoms of *China* and *Japan*, is of little or none in *Europe*, I need not prove to you. I have been in divers places, where beer and ale, which are here the common drinks, are greater rarities than the medicated liquors ſold only in apothecaries ſhops. In divers parts of *Muſcovy*, and ſome other northern regions, the common drink is *Of hydromel.* *hydromel*, made of water fermented with honey; and indeed, if a due proportion betwixt thoſe two be obſerved, and the fermentation be ſkilfully ordered, there may be that way, as experience hath aſſured us, prepared ſuch a liquor, both for clearneſs, ſtrength, and wholeſomeneſs, as few, that have not taſted ſuch a one, would readily believe.

Of ſugar wines. THE French and Engliſh inhabitants of the *Caribbee* Iſlands, make, by fermentation, a wine of the dregs collected in the boiling of ſugar. A like to which *Piſo* tells us, that they make Lib. 4. c. 1. in *Braſil*, and commonly call *garapa*, which, though made by the mixture of water, the inhabitants are very greedy of; and when it is old, find it ſtrong enough to make them drunk. And how alſo in theſe colder countries a good wine may be made of only ſugar and water, we may elſewhere have occaſion to teach you.

Lib. 4. c. 6. AND in *Braſil* they likewiſe, as the ſame author informs us, make a wine (unknown to moſt other regions of the world) of the fruit of *acaju*, which yet, upon his experience, he much commends; telling us, that it is ſtrong enough to inebriate, and may, he doubts not, *Of other Braſilian and Barbados wines.* be kept good many years; and that though it be aſtringent, yet both in himſelf and others he found it diuretical.

IN the *Barbados* they have many drinks unknown to us; ſuch as are *perino*, the plantane drink, *grippo*, punch, and the rare wine of pines, by ſome commended more than the poets do their nectar; ſome of which we therefore make not, becauſe the vegetables, whereof they are produced, grow not in theſe colder climates: but others alſo they have, which we have not, though they are made of plants to be met with in our ſoil; as for inſtance, the drink they call *mobby*, made of potatoes fermented with water, which, being fit to drink in a very few days, and eaſy to make as ſtrong almoſt as the maker pleaſeth, would be of excellent uſe, if it were but as wholeſome as it is accounted pleaſant.

IN the Turkiſh dominions, where wine, properly ſo called, is forbidden by *Mahomet*'s law, the Jews and Chriſtians keep in their taverns a vinous liquor made of fermented raiſins, after a manner, which (when we ſhall elſewhere acquaint you with it) you will eaſily diſcern to be capable of much improvement from the knowledge of fermentation. And in- *The way to make wine of raiſins.* deed by the bare fermenting of raiſins and water, in a due proportion, without the help of barm, leaven, tartar, or other additament to ſet them a working, we have divers times, in a few days, prepared a good vinous liquor, which having for trial's ſake diſtilled, it afforded us greater ſtore than we expected, of inflammable ſpirit, like that of other wine.

BUT I have ſometimes wondered, that men had no more curioſity to try what drinks may be made of the juices obtainable by wounding or cutting off the parts of ſeveral trees, and ſome other vegetables: for that in the *Eaſt-* *Of wines from the dropping or weeping of wounded vegetables.* *Indies* their *ſura* is made of the liquor dropping from their wounded coco-trees, we have not long ſince out of *Linſchoten* informed you. And ſober eye-witneſſes have aſſured us, that in thoſe countries they have but too often ſeen the ſea-men drunk, by the uſe of liquors weeping out of the inciſions of wounded vegetables, and afterwards fermented.

AND that even in *Europe*, the alimental liquor, drawn by trees from the earth, may receive great alterations from them, before it be quite aſſimilated by them, may be gathered from the practice of the Calabrians and Apulians; who, betwixt *March* and *November*, do by inciſions obtain from the common aſh-tree, and the *ornus* (which many botaniſts would have to be but a wild aſh) a ſweet juice, ſo like to the manna, adhering in that ſeaſon to the leaves of thoſe kind of trees, that the natives call it in their language, *manna del corpo*, or trunk manna. And leſt we ſhould think they draw all this ſweetneſs from the ſoil of that particular part of *Italy*, where they grow, you may be ſatisfied by the learned *Chryſoſtomus Magnenus*, in his treatiſe *de Manna*, that it is to be met with in ſeveral other places. And he adds, that in the dukedom of *Milan*, where he profeſſeth phyſick, there is no other manna uſed, than that, which is (as he ſpeaks) *vel è trunco expreſſum* (which he ſomewhere calls *manna truncinum*) *aut in ramis ſtriatim concre-* *De Manna, cap. 18.* *tum*; and that yet it is ſafely and proſperouſly uſed.

I HAD communicated to me, as a rarity, *Of the tears of the walnut-trees.* a ſecret of the king of *Poland*'s, which is ſaid to do wonders in many diſeaſes, and conſiſts only in the uſe of the liquor, which drops about the beginning of the ſpring from the bared and wounded roots of the walnut-tree: but becauſe I have not yet made trial of it my ſelf, I ſhall paſs on to obſerve to you, that in ſome northern countries, and even in ſome parts of *England* bordering upon *Scotland*, the almoſt inſipid liquor, that weeps in *March*, or the beginning of *April*, out of the tranſverſly wounded branches (not trunks) of the birch-

tree,

tree, is wont to be uſed by perſons of quality as a preſervative from the ſtone; againſt which cruel diſeaſe, *Helmont* highly extols a drink made of this liquor and *ſemen dauci* and *beccabunga*, and I think not without cauſe. For not to mention all the commendations, that have been given me of it by ſome that uſe it, I have ſeen ſuch ſtrange relief frequently given, among others, to a kinſman of mine, to whom hardly any other remedy (though he tried a ſcarce imaginable variety) was able to give eaſe, (and in whoſe diſſected bladder, after another diſeaſe had killed him, a ſtone of many ounces was found) that I uſually every ſpring take care to provide a quantity of this water, with which alone, without the other ingredients mentioned by *Helmont*, my kinſman uſed to be relieved as long as he could keep it; which you may do the longer, by pouring upon the top of it a quantity of ſallad-oil, to defend it from the air; and perhaps alſo by diſtillation: by which (laſt named) way, I know an ingenious man, that is wont to preſerve it for his own uſe, and ſays, he finds it not thereby impaired in virtue. But the moſt effectual way, that ever I yet practiſed, *Pyrophilus*, to preſerve both this and other liquors and juices, is dextrouſly and ſufficiently to impregnate them with fume of ſulphur, which muſt be at divers and often times as it were, incorporated with the liquor by the due agitation; the manual operation belonging to this experiment, I may hereafter have occaſion to deſcribe more fully, together with the particular effects of it in ſeveral bodies. And therefore it may here ſuffice to tell you, that if you practiſe it carefully, you will, perhaps, think your ſelf obliged to thank me for the diſcovery of it, though a heedful reader may find it, not obſcurely, hinted in *Helmont*'s writings.

The uſe of the tears of birch, with ſome other ingredients, for the ſtone.

The ways to preſerve theſe liquors.

I MIGHT here annex the great commendation, which I have found given to this birch-water, by eminent writers, againſt the hot diſtempers of the liver, and divers other affections; and eſpecially how *Freitagius* commends it very much to dilute wine with: and adds, *Hæc eſt dulcacida & grati ſaporis, ſitim ſedat, viſcerum & ſanguinis fervorem temperat, obſtructiones reſerat, calculum pellit:* 'This birch-water hath a ſweet ſharpneſs, and very pleaſant taſte; it allays thirſt, and the dryneſs of the entrails; it tempers the heat of the blood; it opens obſtructions, and drives out the ſtone.'

The uſe of theſe tears of birch in hot diſtempers of the liver and hot catarrhs.

In conſilio medicinali in catarrho calido pro principe quodam.

BUT I ſuppoſe you will think it high time for me to proceed to another ſubject; and indeed I ſhould not have ſpent ſo much time in diſcourſing of drinks, but that I am apt to think, that if there were greater variety of them made, and if they were more ſkilfully ordered, they might, by refreſhing the ſpirits, and inſenſibly altering the maſs of blood, prevent and cure (without weakening or much troubling the patient) almoſt as many diſeaſes, as the uſe of our common, unwholeſome and ſophiſticated wines is wont to produce.

FOR in fermentation, the ſulphureous (as chymiſts call them) the active, and the ſpirituous parts of the vegetables, are much better looſened, and more intirely ſeparated from the groſſer and clogging parts, in moſt mixts, than they are by the vulgar ways of diſtillation, wherein the concrete is not opened by previous fermentation. And theſe nobler parts being incorporated with our aliments, are with them received freely, and without reſiſtance carried into the maſs of the blood, and therewith, by circulation, conveyed to the whole body, where their operation is requiſite. And I remember, that diſcourſing one day with an eminently learned and experienced phyſician, of the antinephritical virtue of our common wild carrot-ſeed, fermented in ſmall ale; he ſmilingly told me, that he found its efficacy but too great; for having preſcribed it to ſome of his rich patients, who were wont frequently to have recourſe to him in their nephritical diſtempers, after the uſe of this drink for a pretty while, he ſeldom heard of them any more. And for your encouragement, *Pyrophilus*, to make trials of this nature, we will add, that though the ſeed it ſelf be not over-well taſted, yet being fermented in a due proportion with the liquor (we uſed an ounce and half of the ſeed, to a gallon of the ale) the drink compoſed of both taſted pleaſantly, almoſt like lemmon-beer.

The uſe of daucus ale, and proportion of the ſeed to the liquor.

AND that you may the leſs wonder at the efficacy of fermented liquors, it is worth conſidering, what virtue is aſcribed to the bare decoction of that herb, which the French and we call *Thé*, or *Té*, which is much magnified here; and as far as my little experience in my ſelf, and others (of which more hereafter) reaches, not altogether without cauſe: but among the Chineſe and the Japonians, it is the common drink of perſons of quality, by whom it is ſo highly praiſed, that the experienced *Tulpius*, in the new edition of his *Obſervations*, tells us, that one pound of the Japonical *T'chia* (as the natives call it) is not unfrequently ſold for one hundred pounds of ſilver; which is not to be wondered at, if they juſtly aſcribe to it, that in thoſe countries men are not ſubject to the ſtone, or the gout, and if but one half of the virtues he there attributes to it, be for the moſt part to be found in it.

Of Thé or Té.

Obſ. lib. 4. cap. ult.

I MIGHT, when I told you of the variety of materials not uſed among us, have added one ſtrange drink, which a chirurgeon, that a while ſince lived at in the *Eaſt-Indies*, told me, he ſaw much uſed thereabouts: they make it of the raw fleſh of goats, capons, and the like, which together with rice and moloſſes (or black coarſe ſugar) they put into a quantity of water, and diſtil it in an alembick till the liquor be ſtronger than brandy, (as they call common weak ſpirit of wine, or of lees of vinous liquors,) and this *rack* (as the extravagant liquor is called) is often drank in hot weather, and found very comfortable: thoſe, that uſe it, prizing it much, as ſuppoſing it draws a nutritive and cheriſhing virtue from the fleſh, as indeed, if any quantity of the nobler parts of that, do concur to the conſtituting of the liquor, it may probably be, at leaſt to divers bodies, very wholeſome in that country, where they find ſtrong drinks neceſſary to recruit their ſpirits, exhauſted by the exceſſive

Of animal drinks.

ceſſive heat of the climate. As I remember, the experienced *Bontius*, in his *Medicina Indorum*, tells us, that the merchants travelling through the ſcorching deſarts of *Arabia*, *Perſia*, or *Turkey*, find it beſt to quench their thirſt by a draught of the ſpirit of wine, or elſe of the ſtrongeſt Perſian or Spaniſh wine.

Dialog. 3.

The uſe of brandy wine in hot climates.

AND of the great uſe, if not neceſſity, of either brandy, or ſuch other ſtrong and ſpirituous drinks in the hot climates of the *Indies*, divers intelligent perſons of our own country have, upon their own experience, ſufficiently ſatisfied us.

NOR, *Pyrophilus*, is natural philoſophy able only to improve our drinks, but the reſt of our aliments alſo: for not to mention, that experience hath aſſured us, that by ſkilfully contrived ovens (wherein the heat plays every way about the bread, without yet ſuffering any of the ſmoke or ſteams of the fire to come at it, and wherein what degree of heat you pleaſe may be continued from firſt to laſt) better bread may be baked, than in our common ovens, where the bread reſts upon the hearth, and the heat is continually decaying. Not to mention this, I ſay, phyſiology can enable us to confer a very grateful taſte on very many of the things we eat, barely by a ſkilful and moderate untying and exciting the formerly clogged ſpirits, and other ſapid parts contained in them. It can teach us to make better bread than is commonly eaten. And by diſcovering to us a better art of cookery, than *Apicius* and his ſucceſſors have left us, and by ſubſtituting innocently ſapid things, inſtead of thoſe unwholeſome ones, their deliciouſneſs endears to men; it can teach us to gratify men's palates, without offending their healths: and in preſerving of freſh meats, fruits, *&c.* beyond their wonted ſeaſons of duration, the naturaliſt's ſkill may perform much more than you will readily believe.

The uſe of natural philoſophy to meliorate meats.

AND yet to incline you not to be too diffident in this particular, let me inform you, that much hath been already performed, as to the preſervation of aliments, even by thoſe, that have not troubled themſelves to make philoſophical inquiries after the cauſes and remedies of putrefaction in bodies, but only have been taught by obvious and daily obſervations, that the air doth much contribute to the corruption of ſome bodies, and the excluſion of the air to the hindering it. I remember, the inquiſitive and learned Mr. *Boreel* aſſured me ſome while ſince, that he had in his country, *Holland*, eaten biſket, that was yet good, after it had been carried from *Amſterdam* to the *Eaſt-Indies*, and brought back thence again, (in which voyage, between two and three years are wont to be ſpent.) And to confirm my conjecture of the way of preſerving this bread ſo long, he told me, that the curious merchant, whoſe it was, uſed no other art, than the ſtowing his biſket, well baked, in caſks exactly calked; and beſides carefully lined with tin, for the more perfect excluſion of the air: adding, that to the ſame end the biſkets were ſo placed, as to leave as little room as poſſibly might be in the caſk; which alſo was not opened, but in caſe of abſolute neceſſity, and then preſently and carefully cloſed again.

Of preſerving biſket from putrefaction

I MAY elſewhere tell you of an eminent naturaliſt, a friend of yours and mine, that hath a ſtrange way of preſerving fruits, whereby even gooſberries have been kept for many months, without the addition of ſugar, ſalt, or other tangible bodies: but all that I dare tell you, is, that he aſſures me, his ſecret conſiſts in a new and artificial way of keeping them from the air.

Of preſerving fruits.

BUT it ſeems more difficult, as well as more uſeful, to be able to preſerve meat long without ſalt; for it is ſufficiently known to navigators, how frequently, in long voyages, the ſcurvy, and other diſeaſes, are contracted by the want of freſh meat, and the neceſſity of feeding conſtantly upon none but ſtrongly powdered fleſh, or ſalted fiſh: and therefore, he is much to be commended, that hath firſt deviſed the way to keep fleſh ſweet, without the help of thoſe fretting ſalts men are wont to uſe to make it keep. This way is not unknown to ſome ingenious perſons in *London*. One of the moſt noted of whom, upon my conjecturing, how it may be performed, confeſſed to me, that I had hit upon the way in general. But the moſt ſatisfactory account I could get of it was from an Engliſhman, that lately practiſed phyſick in the *Eaſt-Indies*, who, finding I was no ſtranger to what I aſked him about, told me freely, that he had ſeen both goat's-fleſh, and hen's, ſo well preſerved by this way, that though it were put up in the *Eaſt-Indies* a while before he came thence, yet he eat of it, and found it good and wholeſome between the Iſlands of *Cape Verd*, (as the ſeamen call them) and *England*; ſo that this meat continued ſweet above ſix months, notwithſtanding the heat and cloſeneſs of the ſhip, the exceſſive heat they met with, in their paſſage under the line, and conſequently through the torrid zone; and that the way was only this, that the meat being well roaſted, and cut in pieces, was carefully and conveniently ranged in a very cloſe caſk, into which, afterwards, there was poured as much butter melted, ſkimmed, and decanted from the groſſer and ranker parts, as would fill up all the intervals left between the ſeveral pieces of fleſh, and ſwim about them all, and thereby keep out the air from approaching them; and then the caſk being exactly cloſed, was ſtowed up in a convenient place in the ſhip, and kept unopened till the meat was to be eaten. And it muſt not be omitted, that the relator, and others, that had the care of making proviſion for the voyage, were fain, inſtead of butter made of cow's-milk (which could not be had, where they took in their lading) to make uſe of that made of goat's, or ewe's-milk, which is not (as the Indians make it) ſo good, and to whoſe rankneſs he aſcribed that, which he had obſerved in ſome of the meat buried in it, which he thought might have been preſerved *longer* and *better taſted* (for *wholeſome* and *incorrupt* he ſaid it was) in our European butter; whoſe power to preſerve meat buried in it, after due coction, hath been confirmed to me upon

Of preſerving meats waſted, for long voyages.

their own obſervation, by an experienced officer of the Engliſh fleet, that had the overſight of the proviſions, and by others, that had opportunity to obſerve it.

Of preſerving raw meats.

BUT how much the naturaliſts ſkill may advance the dietetical part of phyſick, by enabling men to make aliments much laſtinger than naturally they are, I muſt not here labour to convince you by other inſtances, that I may not anticipate what we have elſewhere to acquaint you with, from other men's experiments, and our own, about the conſervation of bodies. Only I ſhall at preſent tell you in general, that I hope there will be ways found out to preſerve even raw fleſh it ſelf (for of the keeping of roaſted, we have juſt now given you an inſtance) with things, that do not ſo much fret it, nor give it ſo corroſive a quality, when eaten, as our common ſalt doth. For not to mention what ſeveral curious perſons have practiſed, of ſalting neats-tongues with ſalt-petre, which, though done only to make them look red, ſhews, that a body, not corroſive like common ſalt, may preſerve fleſh; I have, for trial ſake, kept an entire puppy of a pretty bigneſs, untainted for many weeks, (and that in the midſt of ſummer) and that without flaying, drying (by fire, or otherwiſe) or ſo much as exenterating him, or cleanſing him, or doing any thing towards the preſerving of him, ſave the keeping him immerſed in a well-ſtopt veſſel, under ſpirit of wine, (from whoſe taſte, I preſume, meat may be eaſily freed by water;) and there ſeemed ſmall cauſe to doubt, that the only thing, that hindred me from keeping him much longer, was the want of time to purſue the experiment, and take notice of its ſucceſs. For I remember, I have the ſame way kept a ſoft ſubſtance, taken raw from an ox or cow, for many months (if I miſtake not, eighteen or twenty) and found no putrefaction or ill ſcent in the immerſed ſubſtance; which, for aught I know, might have been preſerved divers years together the ſame way, or at leaſt, by an eaſy improvement of this method, of which, I lately intimated, I intend you hereafter an account.

Salting neats-tongues with ſalt-petre.

Of preſerving fleſh in ſpirit of wine.

AND I ſhall further add on this occaſion, that if we reflect upon ſugar, which is (at leaſt in theſe weſtern regions) but an almoſt recent diſcovery, and conſider how many bodies are with it, by confectioners and others, not only preſerved, but rendred exceeding grateful to the taſte; that ſingle inſtance may ſuffice to make us think it probable, that expedients yet unthought of may, by an inſight into nature, be found out, for the preſervation of bodies: eſpecially, if our ingenious friend Mr. *W.* would ſhew us, how out of divers other concretes, beſides the ſugar-cane, a ſubſtance not unlike ſugar (though of different taſte, according to the nature of the vegetable, that affords it) may, by a peculiar induſtry, be prepared. Which, that you may not think unfeazable, let me mention to you (for perhaps he hath not yet taken notice of it) what even Indians have done of this nature. And firſt, let me inform you of what we are told by *Linſchoten* * concerning that drink, which in the *Eaſt-Indies* they call *ſura*, and made of the liquor dropping from the bloſſoms, that they cut away from the Indian palm-tree, which bears the cocoa-nut. For this *ſura*, he tells us, that amongſt other things, they make ſugar (which is called *jagra*) which is made by boiling that liquor, and ſetting it in the ſun, where it congeals to ſugar.

Of conſerving by ſugar, and making ſugar of other concretes beſides the cane.

AND though I muſt not conceal from you, that our author adds, that it is not much eſteemed by reaſon of its brown colour, and for that (to uſe his words) they have ſo great quantity and abundance of white ſugar throughout all *India*; yet the latter reaſon, of the cheapneſs of *jagra*, ſeems to be the principal. For probably, if other ſugars were ſcarce, the melioration of this would be attempted; and it is very likely, that if a ſkilful naturaliſt had the ordering of that ſweet juice, of which the Indians make their *jagra*, he might very well make of it a ſugar of no ſmall uſe; and ſuch a ſugar would be very convenient in many caſes, and to many perſons, for its being different from the common ſugar, though it ſhould not be better. *Garcilaſſus* alſo (a much applauded writer concerning the *Weſt-Indies*) treating of the fruits of a Peruvian tree, called by ſome *Molle*, and by others Mulli, *Conficiunt* (ſaith he) *ex eo potum confricando blandè inter manus in aqua calida, donec dulcor omnis defricetur. Percolant hanc aquam, ſervanique dies tres quatuorve, donec ſubſideat; potus eſt limpidiſſimus, &c. Aqua eadem cocta convertitur in optimum mel.* 'They 'make drink of that *Mulli*, rubbing it gently 'in their hands in hot water, until they have 'rubbed out all the ſweetneſs; they ſtrain 'that water, and keep it three or four days, 'until it ſettle, and then it becomes a very 'clear drink: the ſame water boiled turns into 'good honey—Of this fruit boiled with water 'according to different manners is made wine, 'or good drink, or vinegar, or honey.' And of the ſame plant *Petrus de Cieca* hath this confirming paſſage: *Ex hujus fructu cum aqua decocto, pro coctura modo fit aut vinum ſive potio admodum bona, aut acetum, aut mel.* And that there is a great affinity betwixt ſuch vegetable honeys and ſugar, eſpecially if the juices be ordered with a deſign of turning them rather into ſugar than honey, you may eaſily gather from the next and more memorable inſtance, which we are to mention, and which is afforded us by the diligent deſcriber of the Braſilian plants, who treating of the *Caraguata*, or *Erva Baboſa* (or, as ſome would have it, *Herba innominata caule portulacæ*) hath theſe words to our preſent purpoſe: *Porro* (ſaith he) *radendo novacula petroſa ſtolones, emanat ex concavitate liquor quidam tantâ copiâ, ut ex una ſolummodo planta (mirabile dictu) interdum 50 aut plures arobæ effluant, è quo liquore fit vinum, acetum, mel, & ſaccharum: liquor quippe perdulcis*

Apud Joh. de Laet. deſcr. Indiæ, l. 10. c. 3.

Apud eundem eodem loco.

* *Linſchoten's Voyage*, chap. 56.——When they deſire to have no cocus, or fruit thereof, (namely, of the palm-trees,) they cut the bloſſoms of the cocus away, and bind a round pot, with a narrow mouth (by them called *calao*) faſt to the tree, and then ſtop the ſame cloſe round about with pot-earth, ſo that neither wind nor air can enter in, or come forth; and in that ſort, the pot, in ſhort ſpace, is full of water, which they call *ſura*, and is very pleaſant drink, like ſweet whey, and ſomewhat better.

dulcis coquendo redditur multo ſuavior & ſpiſſior, ita ut tandem in ſaccharum congeleſcat: 'Then 'by cutting the ſhoot with a razor-blade made 'of a flint, there runs out of the cut a certain 'liquor in ſuch a quantity, that (which is 'wonderful) out of one ſingle plant, ſome-'times fifty or more *arobæ* run out: from 'which liquor there is made wine, vinegar, 'honey, and ſugar. For the liquor, ſweet of it 'ſelf, is by being boiled made much ſweeter 'and thicker, ſo that it at length kerns into 'honey.'

SINCE the writing of theſe laſt lines, being viſited by an ancient virtuoſo, governour to a conſiderable colony in the northern *America*, and inquiring of him, among other particularities touching his country, ſomething in relation to the thoughts I had about the making of ſeveral kinds of ſugar; he aſſured me, upon his own experience, that there is in ſome parts of *New England* a kind of tree, ſo like our walnut-trees, that it is there ſo called; whoſe juice, that weeps out of its inciſion, *&c.* if it be permitted ſlowly to exhale away the ſuperfluous moiſture, doth congeal into a ſweet and ſaccharine ſubſtance: and the like was confirmed to me, upon his own knowledge, by the agent of the great and populous colony of the *Maſſachuſets*. And very lately demanding of a very eminent and ſkillful planter, why, living in a part of *America*, too cold to bear ſugar-canes, he did not try to make ſugar of that very ſweet liquor, which the ſtalks of maiz, by many called Indian-wheat, afford, when their juice is expreſſed, he promiſed me he would make trial of it; adding, that he ſhould do it very hopefully, becauſe that though he had never been ſolicitous to bring this juice into a ſaccharine form, yet having ſeveral times, for trial ſake, boiled it up to a ſyrup, and employed it to ſweeten tarts, and other things, the gueſts could not perceive, that they were otherwiſe ſweetned than with ſugar. And he further added, that both he and others had, in *New-England*, made ſuch a ſyrup with the juice of water-melons.

That the naturaliſt may find out new ways to inveſtigate the wholeſomeneſs or inſalubrity of aliments, proved by inſtances out of Sanctorius's Medicina Statica.

NOR, *Pyrophilus*, is it only by teaching men to improve the wholeſomeneſs and taſtes of the aliments, or to keep them long uncorrupted, that the naturaliſt may contribute to the preſervation of man's health; for from the ingenious attempts of *Sanctorius*, in his *Medicina Statica*, we may be invited to hope, that there may be ways, as yet unthought of, to inveſtigate the wholeſomeneſs or inſalubrity of aliments: as he, by the weight of bodies, after having fed on ſuch and ſuch meats, finds, that ſwine's fleſh, melons, and ſome other things, that he names (in the third ſection) do much hinder inſenſible perſpiration, and conſequently are unwholeſome; though, as I take it, it were not amiſs, that before ſuch obſervations be framed into general and eſtabliſhed aphoriſms, they were carefully made in bodies of differing ages, ſexes, and complexions, and with variety of circumſtances. But then again, preſuming theſe maxims to be judiciouſly framed, the ſame *Statica Medicina* makes it hopeful, that there may be unthought of methods found, whereby, by ways different from thoſe formerly uſed by phyſicians, a man may be much aſſiſted in the whole manner of ordering himſelf, ſo as to preſerve health, and to foreſee and prevent the approach of many diſtempers. And perhaps by ſuch unthought of ways, divers paradoxes of concernment to man's health may be made out, as the diligent *Sanctorius* to that obſervation propoſed in theſe words, *Semel aut bis in menſe facto exceſſu in cibo & potu, die ſequenti, licet ſenſibiliter non evacuet, minus ſolito perpendit annexus*, (in the following aphoriſm) addeth this important corollary: *Victus uniformis caret beneficio illorum, qui ſemel vel bis in menſe excedunt: expultrix enim à copia irritata excitat tantum perſpiratus, quantum ſine ſtatica nemo crederet*: 'If once in a month one 'eat or drink to exceſs, the day following, if 'he be weighed (though he hath ſuffered no 'ſenſible evacuation,) yet then he will weigh 'lighter than is uſual. A conſtant diet wants 'the help of thoſe, that once or twice in a 'month do exceed: for the expulſive faculty 'being oppreſſed by too great repletion, ſtirs 'up ſo much of perſpiration, as without the 'ſtaticks no one would believe.' And indeed experience hath informed us, that the promoting or ſuppreſſing of inſenſible tranſpiration, by which, in a day, the body may diſcharge it ſelf of four or five pounds of excrementitious matter, hath a much greater power to advantage or prejudice health, than is wont to be taken notice of: ſo that we ſee, that the ſtaticks, which, though long known, were thought uſeleſs to phyſick, may afford ſeveral important directions in reference to the preſervation of man's health; to which there are likewiſe other ways, whereby the naturaliſt may contribute. For he may alſo deviſe means, whereby to judge of the qualities of aliments, eſpecially drinks, in their reſpective kinds, and likewiſe of the temperature of the air in this or that place aſſigned. We ſhall, in one of the following eſſays, deſcribe to you a ſmall ſlight inſtrument, by the help of which, one, that is acquainted with this or that particular ſort of wine, may give a near gueſs, whether it be embaſed with water or not. And whereas in moſt hot countries, where water being the common drink, it is of great concernment to man's health to be able to make a good eſtimate of the ſalubrity of it; and whereas phyſicians are wont to think water, *cæteris paribus*, the better and purer the lighter it is; this inſtrument preſently manifeſts, without any trouble of weighing in ſcales, what among any waters propoſed is the heavieſt, and which the lighteſt, and what difference there is of gravity betwixt them. And this diſparity may ſometimes be ſo great, that I remember ſome of our Engliſh navigators tell us, that upon bringing home a ſort of water out of *Africa* into *England*, they found by the common way of ponderation, the African water in the ſame bulk to be about four ounces in the pound lighter than the Engliſh. And as the thickneſs or lightneſs of waters may be thus preſently diſcerned by this hydroſtatical way, ſo it is poſſible, by ſome chymical experiments, eaſily enough to diſcover

Sect. 3. Aph. 96.

The difference in tranſpiration betwixt the times after ordinary diet, and after exceſs, tried by the weighing of man's body.

Difference in the weight of waters.

That chymical experiments may discover other qualities in waters.

cover ſome other qualities, wherein waters, that are thought to be of the ſame nature, differ from each other: as we find, that very many pump-waters will not bear ſoap, as rain-waters, and the generality of ſpring-waters will do. Some water will not dye ſcarlet, or ſome other particular colour, becauſe they are ſecretly imbued with ſome kind of ſaline ſubſtance, that hath an operation it ſhould not have upon the ingredients imployed by the dyer. And I have ſometimes diſcovered a latent ſea-ſalt in water, where others ſuſpected no ſuch matter, by pouring into it a ſolution of good ſilver, made in aqua fortis. For as common ſalt, as well as the ſpirit of it, will precipitate the metal out of ſuch a ſolution, in the form of white calx; ſo it ſeemed rational to conceive, that in caſe the water I ſuſpected hath been imbued in its paſſage through the earth with a ſaline quality, though not conſpicuous enough to be taken notice of by the taſte, theſe ſaline corpuſcles diffuſed through the water would, though faintly, act their parts upon the diſſolved ſilver; and accordingly I found, that upon the mixtures of ſuch waters, and the metalline ſolution, there would immediately be produced a kind of whiteneſs (from ſome parts of the metal precipitated by the ſalt:) to avoid which, I have often been fain to uſe, in places where I met with ſuch waters, either rain-water, or that, which is freed from its common ſalt, by a ſlow diſtillation.

And as for the temperature of the air, which is acknowledged to be of exceeding great conſequence, both as to health, and as to the prolongation of life, and which is poſſibly yet of greater moment to both than moſt men imagine, the ſkilful naturaliſt's ſagacity, if it were imployed to that purpoſe, might probably find divers ways of diſcovering the qualities, and conſequently the ſalubrity and unhealthfulneſs of the air in particular places. For the diligent *Sanctorius* (in the ſecond ſection of this *Medicina Statica*) teacheth us, how to eſtimate the healthfulneſs and inſalubrity of the air, by the weight of thoſe men's bodies, that live in it. And beſides this (nice) way, we ſee, that by the late invention of weather-glaſſes, it is eaſy to diſcern, which of two neighbouring houſes, and which of two rooms in the ſame houſe, is the colder. And I remember I have ſometimes bethought my ſelf of a ſlight way (to be mentioned in one of the following eſſays) by the help of which it is not hard to determine, in which of two places propoſed the air is, *cæteris paribus*, the dryer or the moiſter; and to give alſo ſome gueſs, both how much at the ſame time the air of one place exceeds that of the other, and how the temperature of the air changeth in the ſame place, at ſeveral times, either of thoſe qualities. And that the differing operations of ſeveral airs, upon certain ſorts of fleſh hung in them, upon ſome fading colours, upon bodies ſubject to gather ruſt, or to be tarniſhed, and, in a word, upon divers other ſubjects, may be more conſiderable, than men ſeem yet to have taken notice of, I ſhall think it ſufficient to have intimated in this place; being deſirous to haſten to the following eſſay, (wherewith I am to conclude, what I have to offer to you concerning phyſick) that I may have the more time to employ on it.

That the naturaliſt may diſcover the qualities of particular airs.

ESSAY V.

Preſenting ſome Particulars, wherein Natural Philoſophy may be uſeful to the Therapeutical part of Phyſick.

The introduction.

AND now, *Pyrophilus*, the method, that we formerly preſcribed to our ſelves (a little after the beginning of the firſt eſſay) requires, that we conſider a while the Therapeutical part of phyſick, which is indeed that, whoſe improvement would be the moſt beneficial to mankind; and therefore I cannot here forbear to wiſh, that divers learned phyſicians were more concerned, than they ſeem to be, to advance the curative part of their profeſſion; without which, three at leaſt of the four others may prove indeed delightful and beneficial to the phyſician, but will be of very little uſe to the patient, whoſe relief is yet the principal end of phyſick; whereunto the phyſiological, pathological, and ſemeiotical parts of that art ought to be referred. There was a while ſince a witty doctor, who being aſked by an acquaintance of mine (himſelf an eminent phyſician, and who related this unto me) why he would not give ſuch a patient more generous remedies, ſeeing he grew ſo much worſe under the uſe of thoſe common languid ones, to which he had been confined, that he could not at the laſt but die with them in his mouth? briſkly anſwered, *Let him die if he will, ſo he die, ſecundùm artem.* I hope there are very few of this man's temper; but it were to be wiſhed, that there were fewer learned men, that think a phyſician hath done enough, when he hath learnedly diſcourſed of the ſeat and nature of the diſeaſe, foretold the event of it, and methodically employed a company of ſafe, but languid remedies, which he had often before found almoſt as unable to cure the patient, as unlikely to kill him. For by ſuch an unprofitable way of proceeding, to which ſome lazy or opinionated practiſers of phyſick (I ſay ſome, for I mean not all) have, under pretence of its being ſafe, confined themſelves, they have rendred their whole profeſſion too obnoxious to the cavils of ſuch empiricks, as he, that (as the Lord *Verulam* reports) was wont to ſay, your *European* phyſicians are indeed learned men,

men, but they know not the particular cures of diſeaſes; and (unreverently enough) to compare our phyſicians to biſhops, who had the keys of binding and looſing, and nothing elſe. Which brings into my mind what Monſieur *De Balzac* relates (in his witty French diſcourſe, of the court) of a phyſician of *Milan*, that he knew at *Padua*, who being content with a poſſeſſion of his ſcience, and, as he ſaid, the enjoyment of the truth, did not only not particularly enquire into the cure of diſeaſes, but boaſted, that he had killed a man with the faireſt method in the world: *E morto* (ſaid he) *canonicamante, è con tutti gli ordini.* And ſuch ſcoffs and ſtories are readily enough entertained by the major part of men, who ſend for phyſicians, not ſo much to know what ails them, as to be eaſed of it, and had not rather be methodically killed, than empirically cured. And it doth indeed a little leſſen even my eſteem of the great *Hippocrates*'s ſkill, to find mentioned in his writings ſo many of his patients, of whom he concludes, that they died. And I had much rather, that the phyſician of any friend of mine ſhould keep his patient by powerful medicines from dying, than tell me punctually when he ſhall die, or ſhew me in the opened carcaſs, why it may be ſuppoſed he lived no longer. But, *Pyrophilus*, my concern for mankind, and for the reputation of many excellent phyſicians, whoſe profeſſion ſuffers much by the want of either induſtry or charity, in ſuch as we have been ſpeaking of, hath diverted me longer than I thought from telling you, that I ſuppoſe it will be not very difficult to perſuade you, that this ſo uſeful therapeutical part of phyſick is alſo capable of being much improved by a knowing naturaliſt, eſpecially if he be an intelligent and expert chymiſt, as in this eſſay we will ſuppoſe him.

CHAP. I.

That the naturaliſt may invent medicines chymically prepared, more pleaſant than the ordinary Galenical ones.

SOME Paracelſian would, perhaps, ſet forth, how much more eaſy to be taken chymically-prepared medicines are wont to be, than thoſe loathſome and clogging Galenical potions, bolus's, &c. which are not only odious to the takers, but (which is much worſe) are to many ſo offenſive, that either the patients cannot get them down, or the incenſed ſtomach returns them by vomit, before they have ſtayed long enough in the body to do any more than diſtemper it. But I ſhall not much inſiſt on this, becauſe I think wholeſomeneſs to be much more conſiderable in a remedy than pleaſantneſs; though, I confeſs, I could wiſh, that phyſicians were more careful to keep patients from being almoſt as much troubled by phyſick, as by the diſeaſe; and to cure, according to the old preſcription, not only *citò* and *tutò*, but *jucundè* too: eſpecially conſidering, that, as we were ſaying, the loathſomeneſs of ſome medicines maketh the ſtomach reject them, before they can have performed their operations. And it is, I preſume, on this account as much as any other, that at *Oxford* learned and practical phyſicians, of your acquaintance, make very frequent uſe (on patients not feveriſh) of the reaſin of jalap, barely drawn with ſpirit of wine; ſince, as we have tried, ſix, eight, or ten, or more grains, of this almoſt inſipid reſin, being cleanly prepared, according to art, and with a little gum tragacanth, and half its weight of powdered cinnamon, or ſome ſuch thing made up, may be taken in the morning in form of pills, inſtead of a potion; and is wont to evacuate plentifully enough, and yet gripe the patient much leſs than common purges. But, as I ſaid, I ſhall not inſiſt on this. I might better commend the uſefulneſs of chymiſtry to the therapeutical part of phyſick, from hence, that it is probable, that even emptying medicines may, by the Spagyriſt's art, be ſo prepared, as not only to be leſs offenſive than common purges or vomits in the taking, but to be leſs painful in the working: as I have often obſerved, both in myſelf and others, that upon the taking of the clear, and not loathſome mineral waters of *Barnet*, though the medicine wrought with me ten or twelve times in a morning, yet it did neither pain me, or make me ſick, or diſorder me for the remaining part of the day, any thing near ſo much, as a common pill or potion, that had wrought but once or twice, would have done. And I ſhall elſewhere (God permitting) teach you a preparation of ſilver, whereof about three or four grains being made up (with any proper conſerve) into a little pill, is wont to make a copious evacuation of ſerum eſpecially (in bodies, that abound with it) without making the patient almoſt at all ſick, or griping him; inſomuch that I know ſome perſons, both phyſicians and others, with whom though this medicine work frequently in a day, and though (which is ſtranger) once taking of it will with ſome perſons work ſo for two or three, or more days ſucceſſively, yet they ſcruple not to go abroad and follow their buſineſs. And ſome, that take it, tell me, that when it works not with them, as for the moſt part, when it hath freed the body from ſuperfluous ſerum, it will ceaſe, and in ſome bodies will ſcarce purge at all, it neither puts them to pain, nor makes them ſick.

An inſtance in reſin of jalap, mineral waters and the Author's Pil. Lunares.

AND now I am ſpeaking of the painleſs ways of relieving the ſick, I ſhall add, that there is another way, whereby it is to be hoped, many patients may be reſcued from a great deal of pain; and that is, by finding out medicaments, that may in ſeveral diſtempers, that are thought to belong peculiarly to the chirurgeon's hand, excuſe the need of burning, cutting, trepanning, and other as well painful as terrible manual operations of chirurgery. *Helmont* tells us, that he knew a country-fellow, who cured all freſh wounds by a drink, made (as I remember) of burnt *Tilia*. I have informed you in another eſſay, of the cure I obſerved to be made of the exulcerated tumours of one ſick of the king's-evil, by the uſe of beer, altered by a little plant, that did not at all diſturb the taker. If we may believe *Helmont* and *Paracelſus*, *Præcipitatus Diaphoreticus*, taken at the mouth, doth cure, to uſe his own words, *Carcinoma, lupum, & quodlibet*

That the naturaliſt may find out inward medicines able to do chirurgical cures, proved by divers inſtances.

Helmont de febribus c. 14. *See alſo the ſame author in* Tract. quem vocat arcana Paracelſ. Et lib. de Febr. c. 14.

bet Æſthiomenum cacoëthes ulcus, ſive externum ſive internum. And if there be any truth in what hath been affirmed to me by ſeveral eye-witneſſes, as well phyſicians as others, concerning the *weapon-ſalve*, and *powder of ſympathy*, we may well conclude, that nature may perform divers cures, for which the help of chirurgery is wont to be implored, with much leſs pain to the patient, than the chirurgeon is wont to put him to. I know a very ingenious man, that is famous as well for his writings as for a remedy, wherewith he undertaketh to cure conſtantly the exulcerated cancers of women's breaſts, without any conſiderable pain: but having not yet had opportunity to make trial of that which I have lying by me, I ſhall only tell you he aſſures me, that this medicine is indolent, and mortifies the ulcerous parts as far as they are corrupted, without diſordering the party troubled with them; which I the leſs doubt becauſe, that (to add thus much on this occaſion) partly by the colour, *&c.* of this powder, and partly by his own confeſſion to me, it ſeems to be a dulcification of arſenick, firſt fixt with nitre, and then carefully freed from its corroſiveneſs, by very frequent diſtillations of freſh ſpirit of wine. I ſhall ere long have occaſion to teach you a drink, whereby exulcerated (but not cancerous) breaſts have been very happily cured. The learned *Bartholinus*, in his late *Obſervations*, mentions the cure of ſome hurts in the head, done without trepanning, in caſes, where that formidable and tedious operation is wont to be thought neceſſary. As for the terrible way of ſtopping the violent bleeding in great wounds, by ſearing the orifices of the veſſels with hot irons, it would be little needed, if we knew ſuch remedies, as that, which the inquiſitive *Petrus de Oſma*, in his *Curious Letter to Monardes from Peru*, mentions in this paſſage, which I find among his other obſervations: *Anno* (ſaith he) 1558, *in urbe D. Jacobi, quæ eſt in provincia Chyle, quidam Indi captivi ſuras ſibi amputârunt, & eas aſſas præ fame ederunt, & (quod mirabile dictu) cujuſdam plantæ folia vulneribus imponentes, illico ſanguinem ſiſtebant:* 'In the city of 'St. *James*, that is in the province of *Chyle*, 'certain captive Indians cut off the calves 'of their legs, and for hunger eat them, 'and (which is ſtrange) applying the leaves 'of a certain plant to their wounds, imme-'diately they ſtanch the blood.' I knew a rich man, extremely corpulent, who having long had a ſtrange kind of fiſtula in his breaſt, and having travelled from one country to another, to conſult with the ableſt chirurgeons, was at length brought to that paſs, that at a conſultation they reſolved, by opening his breaſt, to try, if they could track the winding fiſtula, and ſave his life: and as the inſtruments, for this ſad operation, lay upon the table, another famous chirurgeon caſually coming into the houſe, told the patient, that he had an art of curing fiſtulas without cutting them open, and without any conſiderable pain or trouble: whereupon the rich man offering him what he pleaſed for the cure, the chirurgeon quickly performed his promiſe, as the patient himſelf, who ſhewed me his breaſt, confeſſed to me, and that by the uſe of an almoſt indolent remedy, which he purchaſed of the chirurgeon, and which by his favour came to my hands: and that even very ill-conditioned fiſtulas may be cured without chirurgical operations, by medicines taken at the mouth, I ſhall e'er long have occaſion to ſhew you by a notable example.

Apud Monard. de ſimplic. medic. *pag.* 84.

In the mean time I ſhall add, that a man, whom I ſuppoſe you have often ſeen, having a while ſince received ſuch a kick of a horſe, as made the doctor and chirurgeon, that tended him, to conclude the part gangrenated, and the patient's condition, by the acceſſion of a violent fever, ſo deſperate, that they deſired to meddle with him no longer; a large doſe of Sir *Walter Raleigh*'s cordial, ſent him by an excellent lady you are nearly related to, not only freed him from his fever, and the delirium that attended it, but, to the wonder of all that obſerved it, reſtored the limb, that was concluded gangrenated, to its former ſoundneſs. *Sir Walter Raleigh's cordial.*

And to bring credit to all theſe relations, I ſhall crown them with that memorable paſſage of *Gulielmus Piſo*, of as great things, that he ſaw done by the illiterate Indians themſelves: *Memini* (ſays he) *in caſtris membra militum globulis ſclopetorum icta, & jamjam ab Europæis chirurgis, tam Luſitanis quàm Batavis, amputanda, barbaros recentibus gummi ſuccis & balſamis à ferro & igne liberâſſe, & feliciter reſtituiſſe. Oculatus itidem teſtis ſum in noſocomiis relicta ulcera & gangrenas ab illis, vel ſolo ſucco tabaci, curata:* 'I remember, that the limbs of 'ſoldiers wounded with gun-ſhot, to have been 'cut off by the advice of our European ſurge-'ons, both Dutch and Portugueſe, thoſe bar-'barous people by recent juices, gums, and 'balſams to have freed them from knife and 'cauteries, and happily cured them. I alſo am 'an eye-witneſs, that with the juice of tobacco 'alone, they have cured wounds given over 'by our ſurgeons.' *What great uſe the Indians make of the juice of tobacco.*

But, *Pyrophilus*, that the making of divers helps to recovery, leſs diſtaſteful, or leſs painful to the patients, is not the only, nor perhaps the greateſt ſervice that chymiſtry may do him that attempts the cure of diſeaſes, I ſhall now endeavour to manifeſt in ſome particulars.

CHAP. II.

That the ſearch of nature by chymiſtry in particular diſcovers the qualities of medicines.

And firſt, the ſkilful naturaliſt, eſpecially if a good chymiſt, may much aſſiſt the phyſician to diſcover the qualities of medicines, whether *ſimple* or *compound*; that the experiments of the Spagyriſts may much contribute to the examining thoſe many things themſelves prepare, you will, I preſume, eaſily grant. That alſo divers mineral waters are of the nobler ſort of medicines, is ſufficiently confeſſed on all hands; and it is known too, that the induſtry of chymiſts hath produced ſome good directions towards the diſcovery of the minerals predominant in divers medicinable ſprings: but I am much miſtaken, if they have not left much for others to do, which may be eaſily done. And I ſcarce doubt, but that by the various ways

ways, that might be propoſed, of trying what ſuch waters hold, and what ſaline or other qualities are predominant in them, not only the nature of thoſe medicinal waters, that are already uſed, might be more thoroughly underſtood; but undetected properties might in many others, that are now not taken notice of, be diſcovered; of ſome of which ways of examining mineral waters, I may elſewhere give you an intimation. And I have made ſeveral trials, that have, I confeſs, much inclined me to think, that the fault is rather in us, than either in nature or chymiſtry, that men do not, by the help of chymical experiments, diſcover more of the nature of divers medicaments, than hitherto they ſeem to have ſo much as aimed at. For though the abſtruſe endowments of ſpecificks will not, I fear, be learned in haſte, otherwiſe than by particular trials and obſervations; yet many ſimples have other qualities, which ſeem chiefly to reſide, though not in an elementary ſalt or ſulphur, yet in a part of the matter that ſeems of kin to a ſalt or ſulphur: ſuch as ſourneſs, ſaltneſs, a cauſtick or a healing faculty, abſterſiveneſs, and the like, upon whoſe account ſuch remedies ſeem chiefly to work in a multitude of caſes. And towards the inveſtigation of ſuch qualities, a chymiſt may oftentimes do much, without making all his trials in human bodies. But though, to illuſtrate this matter, I have ſometimes made ſeveral experiments, yet not having now my notes and obſervations at hand, I ſhall only mention a few things as they offer themſelves to my memory, reſerving the more diſtinct handling of this ſubject to another opportunity; and the rather, becauſe that till ſuch phænomena have been more diligently obſerved, and reduced to their diſtinct ſorts, I would have them looked upon but as hints to farther inquiries, not as ſufficient authority to ground general rules on.

THERE are ſome plants, whoſe juices, eſpecially when the ſuperfluous moiſture is exhaled or abſtracted, will, (ſome by the aſſiſtance of a gentle heat and filtration, and ſome, even of themſelves, in time which I remember, hath in ſome ſucculent plants amounted but to a very few hours) coagulate in part into a kind of ſalt, which, if you pleaſe, you may call eſſential: and by this nitro-tartareous ſalt (as it ſeems to be) thoſe vegetables, whoſe juice affords it (ſuch as are, if I miſtake not their names, parietaria, borrage, bugloſs, &c.) may be diſcriminated from thoſe many others, from whence it is not (at leaſt by the ſame way) to be obtained. And poſſibly alſo theſe ſalts may, to a heedful ſurveyor of them, appear to differ enough from each other in ſhape, taſte, or other obvious qualities, to deſerve to be ſorted into differing kinds.

Of the nitro-tartareous ſalt in ſome vegetables.

IF likewiſe we compare the eſſential ſalts and ſpirits of theſe plants, with thoſe of ſcurvy-graſs, brook-lime, and other vegetables, that are counted antiſcorbutical, and abound in volatile and ſaline parts; and if we alſo examine other plants, by divers chymical operations, and obſerve not only their diſpoſedneſs or indiſpoſition to yield ſpirits or oils by fermentation, or without it; but thoſe other particulars, wherein they will appear to agree with, or differ from each other: there is little doubt but ſuch trials will make them diſcover, to a conſidering naturaliſt, much of their natures and properties, and eſpecially of ſuch as depend chiefly upon the plenty or paucity of the ſaline, unctuous, ſour, ſpirituous, lazy, tenacious or volatile parts.

IT may be alſo obſerved, that the infuſion or decoction of ſome plants, as of brazil, ſenna, &c. will be heightened into a reddiſh colour, by putting alkalizate ſalts, as of tartar, or of pot-aſhes, in the water that extracts their tinctures: whereas acid ſpirits, at leaſt ſome of them, will much impair, if not deſtroy their colour; as a little aqua fortis will immediately turn a red tincture of brazil, made in fair water, into a pale yellow: whereas, on the other ſide, I have obſerved, that a ſmall quantity of a ſtrong ſolution of pot-aſhes, dropt into an infuſion of red-roſe leaves, hath preſently turned it into a muddy colour, that ſeemed to partake of green and blue, but was dark and dirty; whereas a little aqua fortis, or good ſpirit of ſalt poured into the ſame ſimple ſolution, did immediately turn it into a fine red, and ſo it would do the muddy mixture lately mentioned, if it were put to it in a far greater quantity. I obſerved alſo, that with a very ſtrong (though clear and well filtrated) lixivium of pot-aſhes, I could precipitate ſome part of the infuſion or decoction of red-roſes; which groſſer parts, when the mixture was filtrated through cap-paper, remained like a dirty coloured (though ſomewhat greeniſh) mud in the filtre; the fluid and finer part of the mixture paſſing through in the form of a liquor high coloured, almoſt like muſcadine.

Difference in operation between acid and alkalizate ſalts.

AND on this occaſion, I remember, that as galls, a very ſtiptick vegetable excreſcence, will yield a decoction, with which, and copperas, the common ink is made; ſo divers other plants, of notably aſtringent parts, may be employed to the like uſe: for, by caſting vitriol into a decoction either of oaken bark, or red-roſes, or even a bare infuſion of either log-wood, or ſumach, to name now no other plants of the like nature, I have preſently made a mixture, that might make a ſhift to ſerve for writing-ink; but whether all ſtiptick plants, or they only, will with vitriol make an ink, I refer to farther inquiry. And as a ſolution of vitriol, and the decoction of the above-mentioned plants, do precipitate each other to make ink; ſo I remember I have tried, that by diſſolving the cryſtals of pure ſilver (made the common way with aqua fortis, or ſpirit of nitre) in a good quantity of fair water, that the liquor having no colour of its own, the colours it produceth in other bodies may be the better obſerved, I found, that I could with this liquor precipitate out of the infuſions alone of ſeveral vegetables ſubſtances differingly coloured, according to their reſpective diſpoſitions. And ſo I have found, with leſs coſt, that *ſaccharum Saturni*, which ſeems to be a kind of vitriol of lead, whilſt it lies diſſolved in the ſame ſpirit of vinegar, which extracted it from the metal, being

Of ink made by the decoction of divers aſtringent plants, with a little vitriol.

Of ſome metalline precipitations.

being put to the bare infusion of log-wood, *lignum nephriticum*, red roses (to name those I now remember I made trial of) they will precipitate each other.

That sulphureous salts turn the expressed juices of vegetables into a green colour.

I MIGHT farther add, that I have tried, that sulphureous salts, such as oil of tartar, made *per deliquium*, being dropped into the expressed juices of divers vegetables, will in a moment turn them into a lovely green, though the vegetables were of colours differing from that, and from one another, (as I remember one of those vegetables, in which I expected, and found that change, was of a fine carnation.) And I could tell you, that though it be disputed, whether quick-lime have any salt dissoluble in water, and of what sort it is, the examen of that question may be much furthered, by trying, as I have done, that the water of quick-lime, well made, will precipitate a solution of sublimate made in fair water, and will presently turn syrup of violets (which is blue) if well mixed with it, into a fair green. Experiments, I say, of this nature I might easily annex; but having already set down divers of them in what I have written concerning colours, I shall refer you thither: and now only add this observation, that the investigation of divers medical qualities, even of animal substances, may be as much assisted by the naturalist, especially a chymist; as we elsewhere have by the distillation of the *calculus humanus* shewn, how much it differs from the stones, that are found in the earth. And if you take those hard concretions, found at certain times in the heads of craw-fishes, that are wont to be called *lapides cancrorum*, and commit some of them to distillation, and infuse some in vinegar, and others in old Rhenish-wine, or strong white-wine, you will probably discover something of peculiar in the nature of this concrete, of which I may possibly elsewhere make farther mention to you. And not only so, but in some animal substances, you may, by fit experiments, discover notable changes to be made, and their qualities to be much heightened, when the eye scarce perceiveth any change at all, as I have purposely observed, in keeping urine in close glasses, and a moderate heat for many weeks: for at the end of that time, the virtues, that depend upon its volatile salt, will be so heightened, that whereas upon putting spirit of salt to fresh urine, the two liquors readily and quietly mixed, dropping the same spirit upon digested urine, there would presently ensue a hissing and ebullition, and the volatile and acid salts would, after a while, concoagulate into a third substance, somewhat of the nature of sal-armoniack. And whereas the syrup of violets, formerly mentioned, being dissolved in a little fresh urine, seemed to be but diluted thereby, a few drops of the fermented urine tempered with it did presently turn into a deep green: and the same digested urine being dropped upon a solution of sublimate made in fair water, presently turned it white, by precipitating the dissolved mercury. With what (various) success we have likewise made upon some other parts of a human body, as well consistent as fluid, some trials, analogous to what we have recited of urine, I may elsewhere, perchance, take notice to you: but of such kind of observations I must give you but this hint at present.

Of the distillation of the calculus humanus, *and of the concretions, that are called* lapides cancrorum.

The changes in animal substances made by fermentation only, particularly in urine.

Of the mixture of spirit of salt with digested urine.

CHAP. III.

SECONDLY: by these and other ways of investigating the medical qualities of bodies, the naturalist may be enabled to add much to the *materia medica*; and that two several ways.

That the search of nature adds much to the materia medica.

FOR he may, by his several ways of trial, and by his chymical preparations discover, that divers bodies, especially of a mineral nature, that are as yet not at all imployed by physicians, at least internally, may be brought into use by them; and that others, that are naturally so dangerous, as to be used but in very few, and for the most part extreme cases, may with safety be more freely employed. Some modern chymists (as particularly *Glauberus*) have of late prepared remedies not unuseful out of zink or spelter. And I have already mentioned unto you an excellent medical use of silver, of which, prepared (as is there intimated) I have now this to add, that since I began to write of it to you, I met with a considerable person, who assures me, that she her self was by the use of it in a short time, cured of the dropsy, though, by reason of her having a body very corpulent, and full of humours, she have been thought more than ordinarily in danger of that stubborn disease. I have sometimes wondered, that there hath been so little care taken by physicians, and even by chymists, to investigate the qualities of mineral earths, and those other resembling bodies, that are, or may be plentifully enough digged up in most countries, though not the self-same in all; for however men are pleased to pass them slightly over, as if they were but elementary earth, a little stained, or otherwise lightly altered, I have seen great variety of them, that have been digged sometimes within the compass of a little spot of ground: and the differences of divers of them, both as to colour, taste, consistence, and other qualities, have been too great, not to make me suspect they were of very differing natures. And the true *bolus Armenus*, and the *terra Lemnia*, which is now brought us from the island, that gives it that name, (mark'd with a seal, which makes many call it *Terra sigillata*, though that name be for the same reason applied to the *terra Silesiaca*, and other medical earths) have been so esteemed, both by antient and modern physicians, as well against malignant diseases, and the plague it self, as against divers other distempers, that it is the more strange, that (since the greatest part of those two earths, that are now brought into our countries, have not, as the more skilful complain, the true marks of the genuine earths, whose name they bear) physicians have not been more careful to try, whether their own countries could not furnish them with the like, or as good, especially in regard some of the few attempts of that nature, that have of late times been made, may give them as much incouragement. For, not to

By imploying bodies hitherto not imployed.

Of remedies newly prepared out of zink.

The cure of the dropsy, by the pill lunaris.

Of the use of medical earths.

believe

believe the boaſts of the Sileſian *Johannes Montanus* (who paſſeth for the inventor of the *Terra ſigillata Sileſiaca Strigonienſis*) in the writing he publiſhed of the virtues of it, that it is gold prepared and tranſmuted, by provident nature, into an admirable medicine; I find that learned phyſicians prefer it before the Lemnian earth, that is now brought from *Turkey*. And the experienced *Sennertus* gives it this commendation, *Experimentis* (ſaith he) *multis jam probatum eſt, ejus inſignes eſſe vires contra peſtem, febres malignas, venenatorum animalium morſus, diarrhœam, dyſenteriam:* 'It is 'approved by many experiments, that its 'virtues are excellent againſt the plague, 'malignant fevers, the bitings of venemous 'creatures, the diarrhœa, and other fluxes.' What he adds, that the chymiſts name it *axungia ſolis*, brings into my mind (what I ſhall hereafter have occaſion to mention more particularly to you) that I had once brought me a certain earth, by a gentleman, that digged it up in this, or ſome neighbouring country, which, though it ſeemed but a mineral earth, did really afford, to a very expert trier of metals of my acquaintance, a not deſpicable proportion of gold. They have alſo found in *Hungary* an earth, which they call *Bolus Tockavienſis*, which is affirmed by *Crato* (in *Sennertus*) to melt in the mouth like butter, and to have all the other proofs of the true *Bolus Armenus*, and therefore is, by that judicious phyſician, preferred before the modern bole-armony, even that, which was brought out of *Turkey* to the emperor himſelf. And he relates, not only its having ſucceeded very well againſt catarrhs, but his having experimentally found it of great efficacy in the plague, that reigned in his time at *Vienna*. To which I ſhall add, that a very learned and ſucceſsful Engliſh doctor now dead did ſome years ſince, during a great plague, that then raged in the city, where he lived, find a vein of red earth, not very far from that town, and preſcribed it with very good ſucceſs in peſtilential fevers, as I was informed by an ingenious friend of his, that uſed to adminiſter it, and ſhewed me the place, where he digged it.

Epitome ſcientiæ naturalis, l. 2. c. 1.

Inſtances of gold and divers noble menſtruums drawn out of them.

I REMEMBER alſo, the experienced chymiſt *Johannes Agricola*, in his notes upon what *Poppius* delivers of *Terra ſigillata*, after having much commended the *Terra Sileſiaca* in divers diſeaſes, and equalled it to the beſt of *Turkey*, where he had travelled, relates one ſtrange thing of it, with many circumſtances, and in a way, as if he ſpoke upon his own trial; namely, that the ſpirit of *Terra ſigillata*, by which I think he means the *Strigonienſis*, doth, though ſlowly, diſſolve gold as well as an *aqua regis*, and that into a red ſolution; whence in two or three days the gold will fall of it ſelf into a very fine and ſubtile powder. And the ſame author tells us, that he hath ſeen another earth digged at the *Rheinſtran*, not far from *Weſterwaldt*, which was more inclinable to white than to yellow, which is preferable to the Sileſian, and gives more ſalt than it, and diſſolves ſilver better than other menſtruums; ſince, as he ſaith, the ſilver may thereby be eaſily made potable, and be prepared into a very uſeful medicine for the diſeaſes of the head. And for my part, I do not much wonder at the efficacy of theſe earths, when I conſider, that divers of them are probably imbued, as well as dyed, with mineral fumes, or tincted with mineral juices, wherein metal or minerals may lie, as the chymiſts ſpeak, *in ſolutis principiis*; in which form, having neither endured the fire, many of their uſefulleſt parts are more looſe and volatile, and divers of their virtues leſs locked up, and more diſpoſed to be communicative of themſelves, than they are wont to be in a more fixed or coagulated ſtate, or when they have loſt many of their finer parts by the violence of the fire.

Of medicines out of arſenick.

BESIDES, there are ſeveral mineral bodies, which, though perhaps they may not be of themſelves fit for the phyſician's uſe, may, by addition of ſome other convenient body, or by ſequeſtration of the more noxious parts, or by ſome ſuch other chymical preparation, as may alter the texture of ſuch minerals, be rendered fit to increaſe the *Materia Medica*. As I have known, that by a preparation of arſenick, with ſalt-petre, whereby ſome of the more volatile and noxious parts are driven away, and the remaining body ſomewhat fixed and corrected by the alkali of the nitre, it hath, by a farther dulcification with ſpirit of wine, or vinegar, been prepared into a kind of *balſamum fuliginis*, which wonderfully cured a phyſician of my acquaintance, as himſelf confeſſed to me, of dangerous venereal ulcers (divers of which penetrated even to the *meatus urinarius*) which had reduced him to great extremity.

And out of biſmutum.

AND though biſmutum have not, that I know, till very lately, been uſed, unleſs outwardly, and eſpecially for a coſmetick (hereafter to be taught you,) yet the induſtrious chymiſt, *Samuel Cloſſeus*, by calcination, and addition of ſpirit of vinegar, and *cremor tartari*, makes two medicines of it, which he highly extols in the dropſy; and (to reſerve for another place, what I have tried upon tin-glaſs) a very expert chymiſt of my acquaintance doth, by preparing it with common ſublimate (carried up by which, I remember, it hath afforded a very prettily figured body) make it into a white powder, like *mercurius vitæ*, which he aſſures me he finds, in the doſe of a few grains, to purge very gently, without being at all, as *mercurius vitæ* is wont to prove violently enough, emetick.

Apud Schroderum in pharmacop. l. 3. c. 18.

Dr. I. C.

Of the correction of poiſonous medicines.

2. BUT the naturaliſt may add to the *Materia Medica*, not only by inveſtigating the qualities of unheeded bodies, but alſo by gaining admittance for divers, that, though well enough known, are forborn to be uſed upon the account of their being of a poiſonous nature: for by digeſtion with powerful menſtruums, and ſome other ſkilful ways of preparation, the philoſophical ſpagyriſt may ſo correct divers noxious, nay poiſonous concretes, unfit in their crude ſimplicity for the phyſicians uſe, at leaſt in any conſiderable quantity, as to make them uſeful and effectual remedies. *Helmont*, who, though frequently extravagant in his theory of phyſick, doth often make no bad eſtimate of the power

of remedies, after having told us, that he adored and admired the clemency and wiſdom of God, for creating poiſons, gives this account of his ſo doing: *Nam venena* (ſaith he) *noluit nobis eſſe venena aut nocua. Nec enim mortem fecit, nec medicamentum exterminii in terra: ſed potius, ut parvo noſtri ſtudio mutarentur in grandia amoris ſui pignora, in uſuram mortalium, contra futurorum morborum ſævitiam. In illis nempe latitat ſubſidium, quod benigniora & familiaria ſimplicia recuſant aliàs. Ad majores & heroicos medentum uſus venena tam horrida ſervantur:* 'He made not venom to be our 'poiſon, for neither made he death nor any 'deletery medicament upon the earth; but ſo, 'that by a ſlight induſtry and endeavour of 'our own they might be turned into great 'pledges of his love, for the uſe of men againſt 'the cruelty of diſeaſes, which were in pro'ceſs of time to ariſe. For in thoſe venoms 'is the help, that more benign and familiar 'ſimples cannot yield; and thoſe more fright'ful poiſons are yet preſerved in nature for 'the more great and heroick uſes of phyſicians.' And though I would not forbid you, *Pyrophilus*, to think there is ſome hyperbole in the encomiums he here and elſewhere gives poiſonous ſimples; yet when I conſider, what great things are oftentimes performed by antimony, mercury, and opium, even in thoſe not over-ſkilful ways of preparing them, that are divers of them vulgarly uſed by chymiſts, eſpecially when the preparations are (which doth ſeldom happen) rightly and faithfully made; I can ſcarce think it very unlikely, that thoſe active ſimples may, by a more ſkilful way of ordering and correcting them, be brought to afford us very noble remedies. And the ſame examples may in part prevent the main objection, that I can foreſee in this caſe, which is, that whatever corrects poiſons, muſt, with their virulency, deſtroy their activity; for the above-named ſimples, though ſo prepared as to be medicines ſafe enough, have yet activity enough left them to let them be very operative, their energy being, by preparation, not only in part moderated, but in part ſo over-ruled, as to work after a more innocent manner: As in *bezoardicum minerale*, ſkilfully prepared, (for it very ſeldom is ſo) the laxative and emetick virulency of the antimony is changed into a diaphoretick, reſolving, and deoppilative power; which probably made the experienced *Riverius* (though counted a Galeniſt) ſo particularly recommend this medicine to phyſicians, which, if I be not miſtaken, may well be praiſed without being flattered. And *Helmont* ſupplies me with an eaſy experiment to our preſent purpoſe, by telling us, that aſarum, which when crude, doth, as is well known, provoke vomits, by a ſlight preparation (preſently to be mentioned) is ſo altered, that its virulency is changed, to uſe his expreſſion, *in deoppilans, diureticum tardarum febrium remedium*; which I the rather take notice of, becauſe I find, upon enquiry purpoſely made of ſome ingenious phyſicians of my acquaintance, that upon trial, they commend this preparation of *Helmont*'s, and confeſs, that by it the aſarum loſeth its emetick, and acquires a diuretical quality.

Helmont. de pharmac: & diſpenſ. modern. num. 46.

Helmont. tract. ſupra allegato, num. 46, 47.

The preparation of aſarum turns it from being emetick to be notably diuretical.

Now that all other animal and vegetable poiſons may be corrected, without loſing their force with their virulency, is the affirmation of *Helmont* concerning *Paracelſus*'s and his *ſal circulatum (majus.)* And as for vegetables, he elſewhere tells us, that the *Lapis cancrorum* reſolved in *formam*, as he ſpeaks, *priſtinæ lactis, habet remedium contra inclementias multorum vegetabilium vi laxante infamium:* 'That 'the *lapis cancrorum* reſolved into the form of 'its firſt milk affords an antidote againſt the 'violence of many vegetables, that are infa'mous for their being over-laxative.' And I remember, that I knew two phyſicians, the one of which affirmed to me, his having ſeen trial made (by the help of a noble menſtruum) of what *Helmont* here teacheth, and found it true; the other, a perſon ſevere, and apt enough to diſſent from *Helmont*, aſſured me, that with the volatile ſalt of tartar, he had ſeen vegetable poiſons, and particularly napellus, ſo corrected by a light digeſtion with it, that it loſt all its poiſonous qualities: for proof of which, he freely offered me, to take himſelf as much of that fatal herb, as would kill three or four men, (but at that time, and in that place, I could not get any of the plant to make the experiment with.) And though I ſhall ſay nothing now concerning *Helmont*'s *ſal circulatum*, yet as to the volatilization of the ſalt of tartar, what I have ſeen ſcarce permits me to doubt, that it is poſſible. And if I could now clearly acquaint you with my reaſons, you would perchance not wonder to find me inclinable to think, that ſome ſuch methods (perhaps a menſtruum) may be found to correct poiſonous ſimples, without rendring them ineffectual. And though it muſt be ſome very powerful corrective, whether ſalt or liquor, that ſhall be able to correct any ſtore of differing poiſons; yet it is not irrational to think, that divers particular concretes may be prepared without any ſuch abſtruſe or general corrective, ſome by one way of handling it, and ſome by another. And in ſuch caſes, ſkill in the natures of particular bodies to be managed, or lucky hits, may ſupply the place of a meliorating diſſolvent; of which *Helmont* affords me a conſiderable inſtance, where he teacheth, in the place lately quoted, that the emetick property of aſarum may be taken away, and the plant turned into a noble diuretick, only by boiling it while in common water. And whereas a wary man would be apt to ſuſpect, that this change is made but by the avolation of ſome ſubtile parts driven away by the heat of the boiling water, I find, that our author affirms, that though it be boiled with the like degree of fire, in wine, inſtead of water, it will not ſo loſe its violence. I have known white hellebore, opium, and ſome other noxious bodies, ſo prepared, as to be given not only harmleſly, but ſucceſsfully in ſuch quantities, as were they not ſkilfully corrected, would make them pernicious. We daily ſee, that the violent emetick and cathartick properties

Helmont. p. 466.

Helmont. de Litoſt. l. 7. c. 32.

Inſtances in ſome of the ſecret menſtruums.

That the proportion of aſarum is only the boiling it in common water.

Helm. in pharmacop & diſpenſ. modern. n. 46, 47.

That the boiling in wine alters not its violence.

That the emetick and cathartick properties of antimony are deſtroyed by calcination with ſalt-petre, and mercury ſublimate be deprived of its corroſiveneſs by bare re-ſublimations with freſh mercury.

ties of antimony, may ſingly, by calcination with ſalt-petre, be deſtroyed. And (which is though a known, yet a notable experiment among chymiſts) mercury ſublimate may be deprived of its deadly corroſiveneſs, and prepared into a medicine inoffenſive even to children, by bare re-ſublimations with freſh mercury. And to give you one inſtance more of what the knowledge of the effects of chymical operations, and of the diſpoſition of a particular body, may enable a man to do, in changeing the pernicious nature of it; I ſhall add, that the violently vomitive flowers of antimony, which our wonted, though ſumptuous and ſpecious cordials are ſo unable to tame, I can ſhew you (which perhaps you will think ſtrange) ſo corrected, without the addition of any thing beſides heat and ſkill, that in a treble doſe, to that wherein they are wont to be furiouſly emetick, we have not found them to work otherwiſe than gently by ſweat. But ſome more particulars applicable to our preſent purpoſe, you will meet with by and by.

A ſtrange correction of the flowers of antimony,

CHAP. IV.

THIRDLY, and now, *Pyrophilus*, that I am ſpeaking of the ſervice, that the naturaliſt may do phyſick, I muſt not pretermit, that he may aſſiſt the phyſician to make his cures leſs chargeable. For though to cure cheaply, be not properly, and in ſtrictneſs, any part of the end of the art of phyſick, which conſiders men's health, and not their purſe; yet it ought in charity, if not alſo in equity, to be the endeavour of the phyſician, eſpecially when he dealeth with patients, that are not rich. For not to ſay any thing of fees of phyſicians, which in ſome places are not very moderate, it is certain, that the bills of apothecaries, eſpecially in chronical diſeaſes, do often prove ſo chargeable, than even when the remedies ſucceed, by that time a poor patient is recovered, he is undone; and pays, for the prolongation of his life, that, which ſhould have been his livelihood. Whence it comes to paſs, that the more neceſſitous ſort of people are ever fain to languiſh unrelieved, for want of being able to purchaſe health at the apothecaries rate; or are deterred from applying themſelves to the phyſician, till their diſeaſes have taken too deep root to be eaſily, if at all, eradicated: and this oftentimes, not more through the fault of the apothecary, than of the doctor, who in his preſcriptions might, for the moſt part, eaſily direct things, that would be much more cheap, without being much leſs efficacious.

That the naturaliſt may aſſiſt the phyſician to make his cures leſs chargeable.

Now there are ſeveral particulars, wherein it may be hoped, that the naturaliſt may aſſiſt the charitable phyſician to leſſen the charge of his patients.

Inconveniences of ſtuffing receipts with a multitude of ingredients.

AND firſt, he may perſuade the phyſician to decline that more frequent than commendable cuſtom, of ſtuffing each *recipe* with a multitude of ingredients. It is not, that I approve the practice of ſome chymiſts, who too freely cenſure the compounding of ſimples; for I know, at ſome times, a complicated diſtemper requires in its remedy more qualities, than are, perhaps, to be met with in any of the known ſimples, that the phyſician hath at command (though one and the ſame ſimple may ſometimes anſwer divers indications; as a plant, that is hot and dry, may ſerve for a diſtemper that is cold and moiſt.) And I know too, that in ſome caſes to that ingredient, that is as it were the baſis of the medicine, other things muſt be added, either to correct its noxious qualities, or to allay its violence, or to ſerve for a vehicle to convey it to the part affected, or to make it eaſier to be taken by the patient, or to preſerve it from corruption, or for ſome ſuch like reaſon. But yet I think phyſicians may well be more ſparing, as to the number of the things preſcribed, than moſt of them uſe to be, both to ſave charges to their patients (upon which account it is, that I here mention it) and for other conſiderations. For the addition of needleſs ingredients adding to the bulk of the medicine, makes it but the more troubleſome to be taken, and the more apt to clog the ſtomach. And oftentimes the efficacy of the more uſeful ingredients, as well as their quantity in each doſe, is much abated, by their being yoked with thoſe, that are leſs appropriated, or leſs operative. Beſides, it ſeems a great impediment to the further diſcovery of the virtues of ſimples, to confound ſo many of them in compoſitions: for, in a mixture of a great number of ingredients, it is ſo hard to know, what is the operation of each, or any of them, that I fear there will ſcarce in a long time be any great progreſs made, in the diſcovery of the virtue of ſimple drugs, till they either be oftener imployed ſingly, or be but few of them imployed in one remedy. And beſides all this, whereas when one of theſe mixtures is adminiſtered, the phyſician expects but ſuch operations as are ſuitable to the quality, which he conceives will be predominant in the whole compound, ſeveral of the ingredients may have particular qualities that he dreams not of, which working upon a body, that the phyſician conſiders as ſubject only to the ſickneſs he endeavours to cure, may therein excite divers latent ſeeds of other diſtempers, and make new and unexpected commotions in the body. On which occaſion I remember, that whereas parſley is a very uſual ingredient of aperitive and diuretick decoctions and apozems, a famous and learned oculiſt tells me, he hath very often obſerved, that when he hath unawares, or for trial-ſake employed parſley, either inwardly, or even outwardly, to thoſe, that were troubled with great diſtempers in their eyes, he found the medicines, wherein that herb was but one ingredient among many, to cauſe either great pain or inflammation in the eyes. In confirmation of which, I ſhall add, that a while after having a ſlight diſtemper in my eyes, I one day found it upon a ſudden ſtrangely increaſed, without being able to imagine, whence theſe new ſymptoms proceeded, till at length, recalling to mind all I had done that day, I remembered, that at dinner I had eaten ſauce, wherein there was a pretty deal of parſley mixt with other things. And whereas in divers of theſe compoſitions

ſome

ſome noxious ingredients are allowed, upon a ſuppoſition, that their ill qualities will be loſt, by their being, as it were, tempered with the reſt; though this may ſometime happen, yet it would be conſidered, that in treacle (eſpecially at one age of it) the opium doth not, conſidering the ſmall proportion of it to the reſt of the ingredients, loſe much, if any of its power, by being mingled with ſixty odd other drugs; which compoſition poſſibly owes much of its virtue to that little opium. And perhaps one reaſon, why thoſe, that accuſtom themſelves to be ever and anon taking phyſick, though they often eſcape dangerous diſeaſes, (by preventing the accumulation of humours, and taking their ſickneſſes at the beginning) are yet almoſt ever troubled with one diſtemper or other, may be, that by the multiplicity of medicines they take into their bodies, divers things are excited to diſorder them, which otherwiſe would have lain quiet. I am not ignorant, that it may be alledged, that in compounded medicines, as treacle and mithridate, how many ſoever the ingredients be, they do ſo clog and temper one another's activity in the compoſition, that there reſults from them all one or more qualities fit for the phyſician's turn, and which is the thing he conſiders and makes uſe of. And I confeſs, that in ſome caſes this allegation doth not want its weight: for I conſider, that a decoction of galls, and a ſolution of copperas, though neither of them a-part be blackiſh, will, upon their mixture, turn to ink; and that when brimſtone, ſalt-petre, and coals, are well mingled together in a due proportion, they make gun-powder, a mixture, that hath qualities much more active than any of the ſever'd ingredients. But I fear, that when a multitude of ſimples are heaped together into one compound medicine, though there may reſult a new craſis, yet it is very hard for the phyſicians to know before-hand what that will be; and it may ſometimes prove rather hurtful than good, or at leaſt by the coalition, the virtues or the chief ingredients may be rather impaired than improved. As we ſee, that crude mercury, crude nitre, and crude ſalt, may be either of them ſafely enough taken into the body in a good quantity; whereas of ſublimate, conſiſting of thoſe three ingredients, a few grains may be rank poiſon. As for thoſe famed compoſitions of mithridate, treacle, and the like, though I cannot well, for the mentioned reaſons, commend the ſkill of thoſe, that firſt deviſed them; and though I think, that when one or two ſimples may anſwer the ſame indications, they may for the ſame reaſons be more ſafely employed; yet I would by no means diſcommend the uſe of thoſe mixtures, becauſe long experience hath manifeſted them to be good medicines in ſeveral caſes. But it is one thing, to employ one of theſe compoſitions, when trial hath evinced it to be a lucky one, and another thing to think it fit to rely on a huddle of ingredients, before any trial hath manifeſted what kind of compound they will conſtitute. And, in a word, though I had not the reſpect I have for *Matthiolus*, and other famous doctors, that deviſed the compoſitions, whereinto ingredients are thrown by ſcores, if not by hundreds, yet however I ſhould not reject an effectual remedy, becauſe I thought, that it proved ſo rather by chance, than any ſkill in the contriver: and I think a wiſe man may uſe a remedy, that ſcarce any but a fool would have deviſed.

ANOTHER thing, upon whoſe account the naturaliſt (whom we here ſuppoſe an expert chymiſt) may aſſiſt a phyſician to leſſen the expenſiveneſs of his preſcriptions, is by ſhewing, that in very many compoſitions, ſeveral of the ingredients, and oftentimes the moſt chargeable, whether they be proper or no for the diſeaſe, are unfit for the way of management preſcribed, and conſequently ought to be left out. I need not tell you, that ſince chymiſtry began to flouriſh amongſt us, very many of the medicines prepared in apothecaries ſhops, and commonly the moſt chargeable, are diſtilled waters, ſpirits, and other liquors: and he, that ſhall ſurvey the books and bills of phyſicians, ſhall find, that (very few perhaps excepted) the moſt uſual preſcription is to take ſuch and ſuch ingredients (for the moſt part numerous enough) and pouring on them either water or wine, if any liquor at all, to diſtil them *in balneo*, rarely in aſhes or ſand. But I confeſs, I have not without wonder, and ſomething of indignation, ſeen in the preſcriptions of phyſicians, otherwiſe eminently learned men, and even in the publick diſpenſatories, I know not how many things ordered to be diſtilled with others *in balneo*, which in that degree of heat will yield either nothing at all, as the fragments of precious ſtones, leaves of gold, prepared pearl, *&c.* or, if they do yield any thing, (for that hath not been yet, that I know of, evinced) do probably yield but a little naufeous phlegm, or at leaſt ſome few looſe parts, far leſs efficacious than thoſe, that require a ſtronger heat to drive them up; ſuch as ſugar, raiſins, and other ſweet fruit, bread, hartſhorn, fleſh prepared by coction, *&c.* which, though wont to be thrown away with the *caput mortuum*, oftentimes there retain their priſtine texture and nature, or at leaſt are almoſt as much more conſiderable, than that which they yielded in diſtillation, as a boiled capon is, than the liquor, that ſticks to the cover of the pot. And though as to ſome of theſe ingredients it may be thought, that they may yield even *in balneo* ſome of their uſeful parts, yet this can, with any probability, be ſuppoſed but of ſome ſuch ingredients. And even as to them it is but ſuppoſed, that they may yield ſomething in ſo mild a heat; and how that ſomething will be qualified, is but preſumed; at leaſt, by the analogy of the experiments vulgarly made, there ſeems ſo ſmall cauſe to expect, that theſe more fixed ingredients will add half ſo much to the virtue of the medicines, as they will to the coſt; eſpecially ſince, though it could be proved, or were probable, that fixed ſubſtances may communicate their virtues to wine or water, yet it would not follow, that thoſe impregnated liquors, diſtilled *in balneo*, will carry thoſe virtues with them over the helm. All which I have more largely proved

in

in another diſcourſe, where I ſhew, both that the nobler parts of many ingredients, wont to be diſtilled *in balneo*, do commonly remain in the *caput mortuum*; and that it is very unſafe to conclude always the virtues of diſtilled liquors from thoſe of the concretes, that afforded them.

BUT there is another way of putting unfit ingredients into medicines, by confounding thoſe in one compoſition, which, though perhaps they might a-part be properly enough imployed, do, when mixed, deſtroy or lock up the virtues of one another; and of this fault even famous chymiſts themſelves are but too often guilty. I know not how many proceſſes I have met with, wherein ſaline ſubſtances, of contrary natures, are preſcribed to be mingled, as if becauſe they were all of them ſaline, they muſt be fit to be aſſociated; whereas it is evident to any man, that conſiders as well as imploys the operations of chymiſtry, that there are ſcarce any bodies in the world, betwixt which there is a greater contrariety, than betwixt acid ſalts; and as well thoſe, that the chymiſts call volatile, as the ſpirits and ſalts of hartſhorn, blood, fleſh, and the like, as thoſe others, which are made of incineration, as ſalt of tartar, and of all burnt vegetables. So that oftentimes it happens, that by an unſkilful mixture two good ingredients are ſpoiled; as when vinegar, juice of lemons, juice of barberries, and the like, are preſcribed to be diſtilled with other ingredients, whereof the ſalt of wormwood or ſome other plant makes one: for then the acid and alcalizate ſalts working upon one another, grow more fixed, and yield *in balneo* but a phlegm; and ſo ſpirit of urine, which is highly volatile, and ſpirit of ſalt, which is alſo a diſtilled liquor, being mingled together, will, by their mutual operation, conſtitute a new thing, which in ſuch a heat as that of a bath, will yield a phlegm, leaving behind the nobler and active parts con-coagulated into a far more fixed ſubſtance, much of the nature of ſal-armoniack. And indeed where ſalts, eſpecially active ones, are made ingredients of mixtures, unleſs they be ſkilfully and judiciouſly compounded, it often happens, that they ſpoil one another, and degenerate into a new thing, if they do not alſo ſpoil the whole compoſition, and of divers uſeful ingredients compoſe one bad medicine.

That acid and alcalizate ſalts being mixed, grow thereby more fixed, and yield in balneo but a phlegm.

The ſame is obſerved of the mixture of the ſpirit of urine (by it ſelf highly volatile) and ſpirit of ſalt.

CHAP. V.

That the naturaliſt diſcovers the miſapplication and uſe of gems, and divers other coſtly ingredients.

ANOTHER way, by which the naturaliſt (ſkilled in chymiſtry) may help to leſſen the chargeableneſs of cures, is by ſhewing, that as to divers coſtly ingredients, wont to be employed in phyſick, there hath not yet been ſufficient proof given of their having any medical virtues at all, or that at leaſt as they are wont to be exhibited, either crude, or but ſlightly prepared in juleps, electuaries, *&c.* there is not any ſufficient evidence to perſuade us, that their efficacy is as much greater than that of many cheap ingredients, as their price is. I am not altogether of their mind, that abſolutely reject the internal uſe of leaf-gold, rubies, ſaphires, emeralds, and other gems, as things, that are unconquerable by the heat of the ſtomach: for as there are rich patients, that may, without much inconvenience, go to the price of the deareſt medicines; ſo I think the ſtomach acts not on medicines barely upon the account of its heat, but is endowed with a ſubtile diſſolvent (whence ſoever it hath it) by which it may perform divers things, not to be done by ſo languid a heat. And I have, with liquors of differing ſorts, eaſily drawn from vegetable ſubſtances, and perhaps unrectified, ſometimes diſſolved, and ſometimes drawn tinctures from gems, and that in the cold. But though for theſe and other conſiderations, I do not yet acquieſce in their reaſons, that laugh at the adminiſtration of crude gems, *&c.* as ridiculous; yet neither am I altogether of their adverſaries mind. For though I deny not the glaſs of antimony, which looketh like a kind of gem or ruby, will eaſily enough impart to liquors an emetick quality; yet I know too, there is great odds betwixt rubies and other gems (which will endure violent fires, and remain undiſſolved in divers ſtrongly corroſive liquors) and the glaſs of antimony, which is a body ſo far leſs compact and fixed, that ſpirit of vinegar it ſelf will work upon it, and a ſtrong fire will, in no long time, diſſipate it into ſmoke. But that, which I chiefly conſider on this occaſion, is, that it is one thing to make it *probable*, that it is *poſſible*, gold, rubies, ſapphires, *&c.* may be wrought upon by a human ſtomach; and another thing to ſhew both, that they *are wont* to be ſo, and that they *are* actually endowed with thoſe particular and ſpecifick virtues, that are aſcribed to them: nay, and (over and above) that theſe virtues are ſuch and ſo eminent, that they conſiderably ſurpaſs thoſe of cheaper ſimples. And I think, that in preſcriptions made for the poorer ſort of patients, a phyſician may well ſubſtitute cheaper ingredients in the place of theſe precious ones, whoſe virtues are not half ſo unqueſtionable as their dearneſs.

A difference betwixt the fixedneſs of a gem, and of glaſs of antimony.

WHAT ſtrange excellency there may be in the *aurum potabile*, made by a true *adeptus*, or by a poſſeſſor of the liquor alkaheſt, I ſhall not now diſpute, not knowing what powerful and radical diſſolvents, the profound ſkill of ſuch men (if any ſuch there be) may furniſh them with, to open the body of gold. But as for the attempts and practices of the generality of chymical phyſicians to make gold potable, beſides that their attempts to make their ſolutions volatile ſucceed ſo ſeldom, that even learned phyſicians, and chymiſts have pronounced the thing it ſelf unfeaſible; I confeſs, I ſhould much doubt, whether ſuch a potable gold would have the prodigious virtues its encomiaſts aſcribe to it, and expect from it. For I find not, that thoſe I have yet met with, deliver theſe ſtrange things, upon particular experiments duly made, but partly upon the authority of chymical books, many of which were never written by thoſe, whoſe names they bear. And others, I fear, commend *aurum potabile*, prepared after another-guiſe manner, than that we are now ſpeaking of, partly upon a preſumption, that if it be made volatile,

Concerning aurum potabile.

it must be strangely unlocked, and exalted to a mere spiritual nature; and partly upon rational conjectures (as they think them) drawn from the nobleness and preciousness of gold. But for my part, though I have long since bethought my self of a way, whereby I can, in a short time, and a moderate fire, make my menstruum bring over crude gold, in quantity sufficient to make the liquor look, at the first or second distillation, of a high golden colour; yet finding, that I could, by an easy art, quickly recover out of this volatile liquor, a corporal and malleable gold, I dare not brag, that my tincture (as an alchymist would call it) must needs do strange feats, because there is so noble a metal brought over in it. And if this or other preparations of *aurum potabile* prove good medicines, it would be farther inquired, whether the virtues may not in great part be rather attributed to the menstruum, than the gold, (that requiring a very subtile liquor to volatilize it) or to the association of the corpuscles of the gold, with the saline particles of the menstruum, into a new concrete, differing enough from gold, though never so well opened. And as for the nobleness and preciousness of this metal, that depends upon the estimation of men; whence in *America* the Indians, that abound with it, had not such a great value for it. And in divers countries, at this day, it is postponed to iron, or to copper, and hath rather a political (if I may so speak) than a natural virtue. Nor will it follow, that because it is the fixedest and preciousest of metals, that therefore it must be an admirable medicine: for we see, that diamonds, though they be the hardest of bodies, and very fixed ones, and in much greater esteem, *cæteris paribus*, than gold, are yet so far from being accounted highly medicinal, that they are commonly (though perhaps not so deservedly) reckoned among poisons. But I see I have digressed; that, which I chiefly aimed at, being to inculcate, that whether gold and gems, and the like precious ingredients, may be good medicines or no, it were a good work to substitute cheap ones for the poorer sort of patients; and that physicians are much to blame, who prize simples, as drugsters do, according as they are brought from remote countries, and are hard to come by; and cannot imagine, that what doth not cost much money in the shops, can do much good in the body; as if God had made provision only for the rich, or those people, that have commerce with *China* or the *Indies*: whereas indeed it may oftentimes happen, that what the chymists call their *caput mortuum*, and perhaps throw away as an useless *terra damnata*, may have as great virtues, as those nobler parts, as they call them, which they have extracted from it; and a despised simple, nay even an excrement or an insect, may in some cases prove nobler remedies, than those, that men call and think very noble bodies, not to say, than I know not how many extracts and quintessences.

Examples of great medicines drawn from unpromising bodies.

Of the efficacy of unpromising medicines.

I SHALL not trouble you with many instances to prove this doctrine, having more fully discoursed of it, in one part of another treatise. But yet some instances, I suppose, you will here expect, and therefore I shall present you with a few of those, that at present come into my mind.

WHEN the distillation of aqua fortis is finished, the *caput mortuum*, as deserving that name, is wont, by common distillers, to be thrown away; and I have seen whole heaps of it thrown by, as useless, by those, that make aqua fortis in quantity to sell it. And yet this despised substance doth, in common water it self, yield a salt, which being only depurated by frequent solutions and filtrations, is that famous *Panacæa duplicata*, or *arcanum duplicatum*, which that great virtuoso and knowing chymist, the Duke of *Holstein*, whose name it also beareth, thought worth purchasing at the rate of five hundred dollars, and of which the prince's experienced physician thus writes to the industrious *Schroder*: *Mille experimentis salis hujus efficaciam aula nostra comprobavit in melancholicis affectibus, febribus quibuscunque continuis & intermittentibus, calculo, scorbuto, &c. Quin & somnum conciliâsse præsertim in melancholicis non semel notavimus. Dosis à scrup. 1. ad scrup. 2. Libras aliquot quotannis absumimus:* 'Our 'court hath tried the efficacy of this salt in a 'thousand experiments in the diseases of me'lancholy, in all fevers, continuous and in'termittent, in the stone, scurvy, &c. Nay 'more, we have observed more than once, that 'it hath procured sleep, especially in persons 'melancholy. The dose is from one to two 'scruples; we use divers pounds of it in a 'year.' And another very skilful physician, that frequented that excellent prince's court, confirmed to me the same medicine's diuretick and deoppilative virtue. (But upon my own experience I can say little of it, having casually lost a great quantity I caused to be prepared to make trial with, before I had opportunity to imploy it.)

The Duke of Holstein's Panacæa duplicata is made of the vulgarly despised caput mortuum of aqua fortis.

Schroder. pharmacop. l. 3. c. 23.

BUT whereas in the *caput mortuum* of aqua fortis there remains pretty store of easily soluble salt, in the *caput mortuum* of vitriol, when not only all the oil is forced away by the fire, but all the fixed salt is exactly separated by water, there seems to remain nothing but a worthless *terra damnata*. And yet it is of this, that, as I shall teach you ere long, I make those colcothatine flowers, which are possibly a nobler medicine than either the oil, the spirit, or the salt of vitriol.

Flores Colcothatini are made of the caput mortuum of vitriol.

As for the bezoar-stone, which is so often prescribed by physicians, and so dearly paid for by patients, the experienced *Bontius*, a very competent witness in this case, (and whose account of the manner of its generation agrees the best, of any I have seen, with that I received from an intelligent person, that was imployed into *Persia* by the late king) hath in one place a passage concerning it; and elsewhere writes such things of the stone cut out of a man's bladder (though that, whilst crude, be despised as a thing vile and useless in physick) as may be justly applicable to our present purpose: *Cæterum* (saith he, speaking of the *Bezoar-stone*) *quantum ad hyperbolicas hujus lapidis virtutes & facultates portentosas non tantas in eo mille experientiis*

Bontius in c. 45. Garcia ab Orta. A comparison between the bezoar-stone and the stone cut out of man's bladder.

rientiis edoctus inveni: 'But for the exceeding 'and portentous virtues of the bezoar-ſtone I 'have found by a thouſand trials, that they 'are not ſo very great.' And elſewhere ſpeaking of thoſe contemptible and excrementitious ſtones, that are found in human bladders, *Nil porro* (ſaith he) *de his lapidibus addo, ne videar eos elevare, & lithotomos monere, ut vel cum periculo plures mortales ſecent. Hoc certè compertum habeo, lapidem in veſica hominis repertum, urinam & ſudores probè ciere, quod tempore ingentis illius peſtis, quæ anno* 1624 *&* 1625, *Leydam patriam meam, & reliquas Hollandiæ civitates miſerandum in modum vaſtabat, in penuria lapidis bezoartici nos exhibuiſſe memini, & ſudorificum (auſim dicere) melius & excellentius inveniſſe*, &c. 'I ſpeak no more of theſe ſtones, leſt 'I ſhould ſeem by my commendation of their 'virtues to provoke lithotomiſts to make diſ-'ſections at any rate. This I have moſt cer-'tainly experienced, that the ſtone found in 'man's bladder doth well provoke urine and 'ſweat. And particularly in the time of that 'plague, which in the years 1624 and 1625 'miſerably vexed ours, and all other the cities 'of *Holland*, for want of the bezoar-ſtone, I re-'member, I preſcribed this, and found it (let 'me tell you) a more great and excellent 'ſudorifick.'

Idem, c. 46. *Garcia ab Orta.*

Medicines out of ſoot.

SOOT is generally looked upon as ſo vile a thing, that we are fain to hire men to carry it away; and yet, as I elſewhere ſhew, that it is a body of no ignoble nature, ſo I muſt here tell you, that it is no unuſeful one in phyſick. And not to mention, that *Riverius* commends it crude to the quantity of a drachm in pleuriſies; I have tried, with the ſpirit of it well drawn, ſome things, that make me look upon it as a conſiderable liquor. And I know by their own confeſſions, that ſome medicines, even of eminent phyſicians, that paſs under other names, have the ſpirit of ſoot for their principal ingredient. I knew a not unlearned empirick, who was exceedingly cried up for the cures he did, eſpecially in difficult diſtempers of the brain, by a certain remedy, which he called ſometimes his *Aurum potabile* and ſometimes his *Panacæa*; and having obtained from this man, in exchange of a chymical ſecret of mine he was greedy of, the way of making this ſo celebrated medicine, I found, that the main thing in it was the ſpirit of ſoot, drawn after a ſomewhat unuſual, but not excellent manner; in which ſpirit, flowers of ſulphur were, by a certain way, brought to be diſſolved, and ſwim in little drops, that looked of a golden colour.

YOU will eaſily grant, *Pyrophilus*, that there are not any medicines to be taken into the body more cheap and contemptible, than the excrements of men and horſes, and than inſects; and yet that even theſe want not conſiderable medical virtues, we elſewhere ſhew. And (not to meddle with ſuch naſty things, as the groſſer ſort of human excrements, though they, outwardly applied either in powder or otherwiſe, do ſometimes perform ſtrange things,) the juice of horſe-dung, eſpecially of ſtone-horſes, being ſtrongly expreſſed (after the dung hath been a while ſteeped in ale, or ſome other convenient liquor, to facilitate the obtaining the juice, and to afford it a vehicle) doth oftentimes ſo powerfully relieve thoſe, that are troubled with the ſtoppage of urine, with wind, ſtitches, and even with obſtructions of the ſpleen and liver, that you, *Pyrophilus*, and I, know a great lady, who, though very neat, and very curious of her health, and wont to have the attendance of the ſkilfulleſt phyſicians, ſcruples not, upon occaſion, to uſe, as I have known her do, in ſilver veſſels, this homely remedy, and prefer it to divers rich cordials, and even to what ſome chymiſts are pleaſed to call *Eſſences* or *Elixirs*. And with the ſame remedy very many poor people were cured of the plague it ſelf, when it lately ſwept away ſo many thouſands in *Ireland* (and the doctors with the patients, as I was aſſured by a perſon who cured ſo many) as to invite men to ſecure themſelves that aſſiſtance, by refuſing the party the liberty to leave the town. But (to add that upon the by) this perſon, in exchange of a ſecret of mine, confeſſed to me, that the *arcanum*, which had cured ſuch numbers, and to which the juice of horſe-dung was a *ſuccedaneum*, was only a good doſe of the powder of fully ripe ivy-berries, which did uſually, as alſo the horſe-dung, work plentifully by ſweat, and which I preſently remembred to be one of thoſe few things, that *Helmont* commends againſt the plague.

The uſe of horſe-dung.

An arcanum of ivy-berries.

THE medical virtues of man's urine, both inwardly given, and outwardly applied, would require rather a whole book, than a part of an eſſay, to enumerate and inſiſt on: but referring you to what an induſtrious chymiſt hath already collected touching that ſubject, I ſhall now only add, that I knew an ancient gentlewoman, who being almoſt hopeleſs to recover of divers chronical diſtempers (and ſome too of theſe abſtruſe enough) was at length adviſed, inſtead of more coſtly phyſick, to make her morning-draughts of her own water; by the uſe of which ſhe ſtrangely recovered, and is, for aught I know, ſtill well. And the ſame remedy is not diſdained by a perſon of great quality and beauty, that you know; and that too after ſhe had travelled as far as the *Spaw* for her health's ſake. And I remember on this occaſion, that paſſing once through one of the remoter parts of *England*, I was viſited by an empirick, a well-wiſher to chymiſtry, but a novice in it, who preſſing me to communicate to him ſome eaſy and cheap preparation, that he might make uſe of among the country-people; I directed him to diſtil with a gentle heat a ſpirit out of urine, putrified for ſix or ſeven weeks on a dung-hill, or ſome analogous heat, but in well-cloſed glaſſes, or other glazed veſſels; and having rectified this ſpirit once or twice, that it might be rich in volatile ſalt, to give ten, twenty, or thirty drops of it in a convenient liquor for the pleuriſy, for moſt kind of coughs, and divers other diſtempers, as a *ſuccedaneum* to the eſſence of harts-horn. And a while after, this empirick returned me great thanks for what I had taught him: and I found by him and others, that he had cured ſo many with it, eſpecially of pleuriſies (a diſeaſe

Medicines out of man's body.

frequent

frequent and dangerous enough in that country) that this ſlight and ſeemingly deſpicable remedy had already made him be cried up for a doctor, and was like to help him to a comfortable ſubſiſtence.

Medicines out of blood.

GREAT ſtore of healthy men's blood is wont to be thrown away, as altogether uſeleſs, by chirurgeons and barbers, that let men blood (as is uſual in the ſpring and fall) for prevention of diſeaſes; and yet from a man's blood ſkilfully prepared, though without addition of any thing, ſave ſpirit of wine to keep it at firſt from putrifying, may be eaſily obtained a ſpirit and volatile ſalt, that have much the ſame virtues with thoſe of the newly mentioned ſpirit of urine, but more noble (as far as I can gueſs) than either that, or even ſpirit of harts-horn; as having performed in conſumptions, aſthma's, and other obſtinate caſes, ſuch things, as I, as well as others, could not but admire. But in this place, mentioning human blood only *in tranſitu*, I ſhall pretermit what I have obſerved about the preparation of it; yet leaving you a liberty to call for my obſervations upon a medicine, which perhaps is nobler, than the moſt coſtly and elaborate chymical remedies, that are wont to be ſold in ſhops, and which hath been almoſt alone excepted out of the cenſure made by a learned modern writer, of the medicines found out by chymiſtry:

The great effects of millepedes in the ſtone.

I SHALL add but one inſtance more, of the efficacy, that may be found in the moſt obvious and abject creatrues; and this inſtance is afforded me by thoſe vile inſects, commonly called in Engliſh, wood-lice, or ſows, and in Latin *millepedes*; which I have often both recommended to others, and taken my ſelf. What their virtue is againſt the ſtone, the world hath been informed by *Laurembergius*, who hath publiſhed a narrative, how by the uſe of them he was cured, even of the ſtone in the bladder; and he was invited to uſe them by credible information, that others had been cured of that diſeaſe, by the ſame remedy. And of late years in *England*, an empirick being much reſorted to, for the relief he gave in that tormenting ſickneſs, a phyſician, famous for his learned writings, wondring at what was done, was very curious (as himſelf afterwards told me) to find out the empirick's ſecret, and at length was ſo induſtrious as to diſcover, that it was a ſlight preparation of *millepedes*. But my having found them in my ſelf very diuretical and aperitive is not that, which chiefly recommends them to me; for I knew, and lived in the ſame houſe with a pious gentlewoman, much better ſkilled in phyſick, than her ſex promiſed, who having loſt the uſe of one eye by a cataract, and being threatned by the oculiſts with the ſpeedy loſs of the other, eſpecially in regard of her being very aged and corpulent, ſhe nevertheleſs did, for ſome years, to my wonder, imploy her eye to read and work with, without finding, as ſhe told me, any decay in it, or any increaſing danger of a ſuffuſion: and ſhe aſſured me, that her medicine was to bruiſe firſt five millepedes, then ten, then fifteen, then twenty, &c. (daily increaſing the number by five, till it had reached, if I miſtake not, fifty or ſixty) in white-wine (or ſmall-ale) and to drink upon an empty ſtomach the ſtrongly expreſſed liquor; and when I deſired to know, how ſhe came by this ſpecifick, ſhe anſwered me, that having made inquiries among all thoſe, both oculiſts and others, that ſhe thought might aſſiſt her againſt ſo ſad a diſtemper, ſhe was adviſed to the uſe of millepedes, by a woman, that not only much magnified their virtue in ſuch caſes as hers, but aſſured her (if I much miſ-remember not) that ſhe her ſelf had been cured by them, of no leſs than an incipient ſuffuſion in one or both of her eyes.

In ſuffuſions of the eyes.

[SINCE the writing of the former part of this page, relating what I newly told you to a very ingenious phyſician, he aſſures me, that being ſome years ſince in *Holland*, he there met with a woman, who was cured, as her ſelf confeſſed to him, of a real cataract, by the juice of millepedes, beginning with that of three at a time, and ſo increaſing to nine at once, and then gradually leſſening the doſe by one inſect each day, till ſhe were come back to three at a time; after which, ſhe gradually increaſed the doſe as before. And he adds, that this woman was adviſed to this medicine by an empirick, that was ſaid to have performed divers cures with the ſame medicine.]

And real cataracts.

[WHAT ſtrange things theſe ſame millepedes have done in the ſore, and even exulcerated, breaſts of women (provided they be not cancrous) though they be given without preparation only to the number of three at firſt, and ſo on to nine at once (which number may perhaps be uſefully increaſed) ſtamped with a little white-wine or beer, that the liquor ſtrained out may be drank in a draught of beer, morning and evening; during which time, linnen cloaths dipped in white-wine, and applied warm, are to be kept upon the breaſt; I may elſewhere have a fitter opportunity to relate. I ſhall now only ſubjoin, as a further proof of the great virtue, that may be even in vile and coſtleſs inſects, and that without any elaborate or chymical preparation, this memorable ſtory; that after all the trials I had made about theſe millepedes, I met with a young lady, who by divers ſtrangely winding and obſtinate fiſtulas, that had made themſelves orifices in many places of her body, was not only lamed, but ſo conſumed and weakned, that ſhe was ſcarce able to turn her ſelf in her bed; and this, notwithſtanding the utmoſt endeavours of the eminenteſt chirurgeons, both Engliſh and foreigners, that could be procured: but when both the hopes of her friends, and thoſe, that endeavoured to cure her, were loſt, ſhe was in a ſhort time not only freed from her fiſtulas, but recovered to a thriving condition of body, by the frequent uſe of an internal medicine, which, as both her parents, and the perſon, that taught it them, informed me, was only a drink (to be taken twice or thrice a day) made of a ſmall proportion of a couple of herbs, (very common, and not much more likely to do wonders in this caſe, than wormwood and mint;) and of three hundred of theſe millepedes well beaten (when their heads are pulled off) in a mortar,

In ſore breaſts and fiſtulas.

and

and tunned up with the herbs, and ſuſpended in four gallons of ſmall ale, during its fermentation. The wonderful efficacy of this medicine in this and many other caſes, which by occaſion of this cure were related to me, being almoſt wholly aſcribed to the millepedes, by the illuſtrious imparter of it, whoſe leave I have not yet, by naming him, to diſcloſe, that this is the ſecret he makes uſe of.

CHAP. VI.

That the naturaliſt diſcovers how much of the coſt and labour in making many chymical remedies may be ſpared.

ANOTHER way there is, whereby the naturaliſt may aſſiſt the phyſician to make the therapeutical part of phyſick leſs chargeable; and that is by ſhewing thoſe, that are wont to employ moſt chymical remedies, that much of the coſt and labour in many caſes might be ſpared. I am not altogether of their mind, that indiſcriminately cry down chymical preparations as exceſſively dear: for of many of thoſe that ſeem very dear, when bought by the pound or the ounce, a doſe may be cheap enough. As if, for inſtance, an ounce of precipitate of gold, and mercury, coſt ten times its weight of ſilver, under which rate I have bought it of honeſt men, that make it themſelves, yet that ounce containing 480 grains, (of which three or four may be a doſe) a taking of this dear powder may coſt far leſs than a doſe of many Galenical medicines, where the quantity, that is taken at once, makes up what is wanting in the coſtlineſs of the ingredients. But though this be the caſe of ſome chymical remedies, yet we muſt not deny, that many others are chargeable; and though perhaps not more ſo than many Galenical ones employed for the ſame purpoſes, yet if thoſe be dearer than they need be, that grievance ought to be redreſſed in chymical medicines, how juſtly ſoever the ſame thing may be imputed to Galenical ones.

A compariſon of chymical remedies with Galenical ones in point of cheapneſs.

Now there are two particulars, wherein the chymiſts, and thoſe phyſicians, that imitate them, are wont to be blameable in reference to this matter; the one their employing chymical preparations on all occaſions, even where ſimples or ſlight compoſitions might ſerve the turn; and the other is, their making many of their preparations more laborious, and conſequently more chargeable than needs.

Of the uſe and commendation of ſimples, even by the moſt able chymiſts.

As for the firſt of theſe: it is known there are divers chymiſts, and others, that practice phyſick, who ſo doat upon the productions of their furnaces, that they will ſcarce go about to cure a cut finger, with leſs than ſome ſpagyrical oil of balſam; and in ſlight diſtempers have recourſe to chymical, and perhaps to mineral remedies, which being, for the moſt part, ſuch as vehemently alter the body, eſpecially by heating and drying it, they do often more harm than good, when employed in caſes, that need not ſuch active medicines. And methinks thoſe, that practiſe, as if nature preſented us nothing worth the accepting, unleſs it be cooked and perfected by *Vulcan*, might conſider, that *Paracelſus* himſelf oftentimes employeth ſimples for the cure even of formidable diſeaſes. And though for particular reaſons I be inclinable enough to think, that ſuch ſearching and commanding remedies, as may be ſo much of kin to the univerſal medicine, as to cure great numbers of differing diſeaſes, will be hardly obtained without the help of chymical preparations, and thoſe perhaps of minerals: yet as to moſt particular diſeaſes, eſpecially when not yet arrived to a deplorable height, I am apt to think, that either ſimples, or cheap or unelaborate Galenical mixtures, may furniſh us with ſpecificks, that may perform much more than chymiſts are wont to think, and poſſibly be preferable to many of their coſtly magiſteries, quinteſſences, and elixirs. *Helmont* himſelf, a perſon more knowing and experienced in his art, than almoſt any of the chymiſts, ſcruples not to make this ingenious confeſſion: *Credo* (ſaith he) *ſimplicia in ſua ſimplicitate eſſe ſufficientia pro ſanatione omnium morborum:* 'I believe 'ſimples in their own ſimplicity are ſufficient 'for the curing of all diſeaſes.' And elſewhere he truly affirms, that there may be ſometimes greater virtue in a ſimple, ſuch as nature affords it us, than in any thing, that the fire can ſeparate from it. And certainly the ſpecifick properties of divers, if not moſt ſimples, are confounded and loſt by thoſe preparations, wherein that texture, which is the foundation of thoſe properties, is either deſtroyed by the fire, or changed by the taking away of ſome of the parts; or the adding of ſome other ſubſtance to it, with which compounded, it may conſtitute a new thing. The more judicious of the chymiſts themſelves do ſeveral of them now acknowledge, that the bare reducing of pearls to fine powder, affords a medicine much richer in the virtues of the pearls, than the magiſtery, prepared by diſſolving them in acid ſpirits, and precipitating them with oil of tartar, and afterwards ſcrupulouſly edulcorating them. And one may eaſily obſerve, that by making the magiſtery of harts-horn the ſame way, the virtues ſeem to be more locked up than they were in the crude horn; which may eaſily enough impart its virtue in the body, ſince fair water will reduce a good part of it into a jelly; whereas the magiſtery remains a fixed powder not eaſily diſſoluble, even in acid menſtruums; and, which thrown upon hot iron, will ſcarce ſend forth that ſtinking ſmoke, which argues the avolation of the ſaline and ſulphureous parts. I never knew any of the vulgar chymiſts eſſences or elixirs half ſo powerful a remedy to ſtanch blood, as a ſlight mixture of two drachms of hyoſcyamum, or henbane ſeed, and the like weight of white poppy-ſeeds, beaten up with an ounce of conſerve of red-roſes, into a ſtiff electuary; with which, given in the quantity of a nutmeg, or wall-nut, I have ſnatched ſome, as it were, out of the jaws of death; and with which an eminent phyſician, now dead, affirmed, that he, and the inventor of the remedy, had very frequently cured profuſe bleedings at the noſe; and in women, at other parts beſides. Nor did I ever ſee, to give an inſtance in a reſembling diſeaſe, ſuch wonderful effects againſt ſpitting and vomiting of blood, of the moſt elaborate chymi-

Helmont. Pharma. & Diſpenſat. Nov. p. 458.

Powder of pearl more operative than magiſtery.

So crude hartſhorn, than magiſtery.

An excellent ſimple medicine to ſtanch blood.

Another like medicine for ſpitting and vomiting of blood.

cal preparations, as I have of a ſlight ſyrup, made only of a convenient quantity of fine ſugar, and the ſtrongly expreſſed juice of twelve handfuls of plantane leaves, and ſix ounces of freſh comfrey-roots well beaten together; with which ſyrup, beſides what I have tried myſelf, two eminent phyſicians performed in that diſeaſe unuſual cures, though (for reaſons elſewhere mentioned) I forbear to name them, otherwiſe than by telling you, that one of them is that ingenious and friendly Dr. *T. C.* to whoſe ſkill both you and I owe ſo much.

BUT I conſider farther, that as oftentimes thoſe I am reaſoning with, make uſe of chymical remedies, when much more eaſily parable ones may ſuffice; ſo in divers caſes, where ſpagyrical medicines are proper enough, their preparations of them are more tedious and expenſive than is neceſſary. There are more than a few, who ſeldom preſcribe, and ſeldomer eſteem a chymical proceſs, that is to be perfected in leſs than many weeks; as if a chymical medicine, like an embryo, muſt needs be an abortive, if it be produced in leſs than ſo many months. And as if in preparations the virtue depended leſs on the ſkilfulneſs, than the elaborateneſs, they ſeem to eſtimate the efficacy of remedies by the time and pains requiſite to prepare them, and dare not think, that a medicine can quickly cure, that was not long a making; as indeed theirs (eſpecially where cohobations and digeſtions, till they have ſuch and ſuch effects upon the matter to be wrought on by them, are preſcribed) are many of them far more toilſome and tedious than thoſe, that have but read ſuch proceſſes, without working them, are apt to ſuſpect. And this is the humour of divers, not only as to thoſe ſtable medicines, that ought always to be found ready in apothecaries ſhops, but even as to thoſe, that are deſigned for particular caſes, and perhaps acute diſeaſes; in which emergencies, if a phyſician had no other remedies than thoſe he muſt make according to ſuch proceſſes, it would, I fear, too often happen, that before the medicine could be ready, the patient would either be paſt the need of it, or paſt the help of it. And that, which oftentimes increaſeth the tediouſneſs of chymical proceſſes, is the unſkilful preſcriptions of thoſe, that deviſe them. It is not unuſual in chymiſts writings to meet with proceſſes, wherein the matter to be prepared, is expoſed to I know not how many ſeveral ſucceſſive operations: but if you ſhould aſk, why ſuch a thing ſhould be, for inſtance, rather precipitated, than exhaled *ad ſiccitatem*; or why ſuch or ſuch an operation is to be uſed after ſuch another, rather than before it; nay, perhaps, if one ſhould demand, why ſome of thoſe operations ſhould be uſed at all, the deviſers of thoſe unſkilful proceſſes would poſſibly as ſoon be able to finiſh their operations, as to give a ſatisfactory anſwer. Nay, ſometimes they lengthen their proceſſes by operations, ſo injudiciouſly preſcribed, that they croſs one another; and the chymiſt vexeth himſelf, and the matter he works upon, to leave it at laſt no better, if not a worſe, medicine than he found it; of this we have already given an inſtance in the common magiſteries.

That many times chymiſts, by their tedious and injudicious preparations, alter the medicine, and make it worſe.

BUT I lately met with another example of it, in the writings of a famous, modern chymiſt; where, to purify the fixed ſalt of vegetables to the height, after I know not how many ſolutions, filtrations and coagulations (which alone would abundantly ſerve the turn) he preſcribes the diſſolving them in aqua fortis; after which, he ſaith, they will become very pure and cryſtalline, and not ſo eaſily reſoluble in the air: of which I make no doubt; for divers years before I met with his proceſs, I have, with the fixed ſalts of more than one kind of vegetable, by joining them with aqua fortis, and after a while exhaling the ſuperfluous moiſture, made good inflammable ſalt-petre; by which you may eaſily gueſs, how judiciouſly the ſolution in aqua fortis is preſcribed only as a farther depuration, and how fit ſuch authors are to be credited, when they aſcribe to theſe cryſtalline ſalts the ſeveral virtues (and thoſe improved too) of the reſpective vegetables, from which the alkalies were obtained. And indeed, as to thoſe exact depurations, which ſome chymiſts ſo ſtrictly require in all their preparations, though their proceſſes be oftentimes hereby made incredibly tedious, I will willingly allow, nay aſſert, that in ſome caſes, and eſpecially in the making of powerful menſtruums, which by their activeneſs and penetrancy are to unlock other bodies, chymiſts do rather err in making their depurations leſs exquiſite than they ſhould, than on the other hand. Yet in many other caſes, ſuch exact refining and ſubtiliation of a remedy is not ſo neceſſary as they imagine; and ſometimes too may do more harm than good, by ſequeſtering thoſe parts of a ſimple, as *fæces*, which concurred with the finer parts to that determinate texture, whereon the ſpecifick virtues of it did principally depend: but of this, more elſewhere. And therefore I ſhall here preſent you with two or three inſtances, to ſhew you, that remedies, at leaſt as noble, as ſuch vulgar chymical ones, as are moſt tedious and coſtly, may be prepared in a ſhorter time, and cheap enough to be fit for the uſe of the poor.

So the diſſolving the ſalts of vegetables in aqua fortis, to make them pure and cryſtalline, alters their virtues, and makes them inflammable as ſalt-petre.

AND to comply, *Pyrophilus*, with your curioſity to know the preparations of thoſe chymical medicines, that I do the moſt familiarly imploy, the three following inſtances ſhall be of ſuch, namely, the *flores colchotharis*, the *balſamum ſulphuris craſſum*, and the *eſſentia cornu cervini*, that you may ſee what ſlight and eaſy preparations afford the remedies, whoſe effects you have ſo often heard of, if not alſo ſeen.

THE firſt of theſe is the ſame powder, which paſſeth under the name of *ens Veneris*; which appellation we gave it, not out of a belief, that it equals the virtues aſcribed by *Helmont*, to what he calls the true *ignis Veneris*, but partly to diſguiſe it a little, and partly upon the account of the occaſion, whereon it was firſt found out; which was, that an induſtrious chymiſt (whom you know) and I, chancing to look together upon that tract of *Helmont's*

Helmont's which he calls *Butler*, and to compare it ſomewhat attentively with other paſſages of the ſame author, we both reſolved to try, whether a medicine, ſomewhat approaching to that he made in imitation of *Butler*'s ſtone, might not be eaſily made out of calcined vitriol: and though upon trials we found this medicine far ſhort of what *Helmont* aſcribes to his, yet finding it no ordinary one, we did, for the mineral's ſake it is made of, call it *ens primum Veneris*.

The preparation and virtues of ens Veneris.

THE preparation, in ſhort, is this: Take good *Dantzick* vitriol (if you cannot get Hungarian or Goſlarian) and calcine it till the calx have attained a dark-red, or purpliſh-colour; then, by the frequent affuſion of boiling, or at leaſt warm water, dulcify it exactly: and having freed it as well as you can, from the ſaline parts, dry it thoroughly, and after mix it exquiſitely, by grinding, or otherwiſe, with an equal weight of pure ſal armoniack, very finely powdered. Put this mixture into a glaſs retort, that may be but a third part filled with it, and ſubliming it in a ſand-furnace, by degrees of fire, for ten or twelve hours, towards the latter end increaſing the fire, till the bottom of the retort (if you can) be brought to be red-hot. That which is ſublimed muſt be taken out, and if it be not of a good yellow, but pale, (which uſually happens for want of an exact commiſtion of the ingredients) it may be returned to the reſidue, mingled better with it again, and ſublimed once more. The yellow or reddiſh ſublimate may be ſublimed a ſecond time, not from the *caput mortuum*, but by it ſelf; but if you re-ſublime it oftener, you may, though you will think that ſtrange, impair the colour and the ſublimate, inſtead of improving them. The doſe is from two or three grains to ten or twelve (in ſome bodies it may be increaſed to twenty or thirty, without danger) in diſtilled water, or ſmall-beer, or other convenient vehicles: it may be given at any time upon an empty ſtomach, but I moſt commonly give it at bed-time. It works, when it works ſenſibly, by ſweat, and ſomewhat by urine. That it is a potent ſpecifick for the rickets, I think I ſcarce need tell you, *Pyrophilus*, whoſe excellent mother and aunt, together with ſome phyſicians, to whom I alſo gave it ready prepared, have cured perhaps a hundred, or more, children, of that diſeaſe, divers of whom were looked upon, as in a deſperate condition. I give it alſo in fevers, and other diſtempers, to procure ſleep, which it uſually doth, where it is wanting. In the head-ach likewiſe, in which, if the diſeaſe be inveterate, the remedy muſt be long continued; with the like admonition it hath done wonders *in ſuppreſſione menſium obſtinata*. In the worms it hath ſometimes done ſtrange things; and for provoking of appetite, I remember not, that I have either taken or given it without ſucceſs. And though I ſeldom take (for I often give more) above two or three grains of it at a time, yet in that ſmall doſe it uſually proves diaphoretical to me the next morning.

BUT the experiments we have had of the ſeveral virtues and efficacy of this medicine, would be here too tedious to recite, and therefore I ſhall now paſs them by; though, if you require it, I ſhall not be backward to ſet you down, by way of obſervations, moſt of the caſes wherein I or my friends have given it, and of the principal cures that have been performed by it. In the mean time, becauſe this exalted colcothar, being given in ſo ſmall a doſe, may prove, if it be rightly and dexterouſly prepared, what *Helmont* ſaith of his imitation of *Butler*'s drif, *a medicine for the poor*, and yet requires more care, not to ſay ſkill, to prepare it well, than by the bare reading of the proceſs you will imagine; I ſhall, to gratify your charity, annex to the end of this eſſay (for to inſert them here would make too prolix a digreſſion) as many of the particulars relating to the preparation of it, as I can readily meet with among my looſe notes. And leſt you ſhould think me a mountebank for want of knowing in what ſenſe it is, that I commend this and the other particular medicines, I ſhall likewiſe, to thoſe obſervations, ſubjoin a declaration of my meaning in ſuch particulars, and of the ſenſe, wherein I deſire you ſhould underſtand what you meet with in the praiſe of remedies, either in this eſſay, or any other of my writings, which I hope it will be ſufficient, to give you this advertiſement of, once for all.

THE next medicine, I am to mention to you, is the *balſamum ſulphuris*, which being made but with groſs oils, drawn by expreſſion, may be called *craſſum*, to diſtinguiſh it from the common and thinner balſam of ſulphur, that is made with the diſtilled oil or ſpirit of turpentine.

The preparation and virtues of the balſamum ſulphuris craſſum.

THIS balſam is made in an hour or leſs, without a furnace, only by taking to one part of good flour of brimſtone, four or five times as much (in weight) of good expreſſed oil, either of olives, or nuts, or poppy-ſeeds, and boiling the former in the latter, in a pipkin half filled with both, till it be perfectly diſſolved into a blood-red balſam. But as eaſy as this preparation ſeems (and indeed is) to them, that have often made it, it will not at firſt be ſo eaſy to make it right. For the fire, which ought to be of well kindled coals, muſt be kept pretty quick, and yet not over-quick, leſt the oil boil over, or do not well diſſolve the flower of ſulphur, but turn them with its ſelf into a clotted and almoſt liver-coloured maſs. And to avoid theſe inconveniences, and the aduſtion of the matter, ſpecial care muſt be had to keep it conſtantly ſtirring, not only whilſt the pot is over the fire, but after it is taken off, till it be quite cold. You may, if you think fit, diſſolve this ſimple balſam in chymical oil of aniſe-ſeeds, or any other eſſential oil, like to advance its efficacy in this or that particular diſtemper; but thoſe oils being generally very hot, I moſt commonly preſcribe the balſam without thoſe additions, eſpecially if long digeſtion have ſomewhat leſſened the offenſiveneſs of the ſmell, which though no peculiar fault of this preparation, being common to ſulphureous medicines, is yet the chief inconvenience of it. I will not reſolutely affirm, that this is the very *balſamum ſulphuris Rulandi*, of which that author relates ſuch wonderful

things

things in his Centuries; but if it be not the ſame, it is ſo like it, and ſo good, that I doubt not but by peruſing thoſe Centuries, you may find divers uſes of it, that I have not made trial of. And in coughs, old ſtrains, bruiſes, aches, (and ſometimes the incipient fits of the gout itſelf) and eſpecially tumours, ſome of your friends can inform you, that it doth much greater things, than moſt men would expect from ſo ſlight and eaſy a preparation; and indeed greater than I have ſeen done by very coſtly and commended balſams and ointments, ſold in apothecaries ſhops. And in thoſe obſervations, I lately told you, you might command, you will find, that this balſam outwardly applied hath cured ſuch obſtinate tumours, as men either knew not what to make of, or what to do with them, of which ſkilful phyſicians, to whom I gave it to make trial of in difficult caſes, can bear me witneſs; though it ought ſufficiently to endear this balſam to us both, that it was the means of reſcuing your fair and virtuous ſiſter *F.* from a dangerous conſumption. In outward application it is to be well warmed, and to be chafed into the part affected, which ſhould be afterwards kept very warm, or elſe lint dipt in it may be kept upon the place. Inwardly ſome drops of it may be given at any time, when the ſtomach is not full; either rolled up with ſugar, or mingled with any convenient vehicle. But as for the particulars, that concern the preparation of this balſam, you will find thoſe I can readily meet with among my looſe papers, annexed, with the notes concerning *ens Veneris*, to the end of this eſſay.

The preparation and virtues of eſſence of harts-horn.

And therefore I ſhall now proceed to mention the third medicine, which you have often heard of, under the name of eſſence of harts-horn; but which is indeed only the ſimple, but well purified and dephlegmed ſpirit of it. And though men are pleaſed to imagine, by the effects this remedy often produces, that I have ſome myſterious or elaborate way of preparing it, yet, to deal ingenuouſly with you, the chief thing I have done to bring it into credit, is the teaching ſome phyſicians and apothecaries a ſafe and eaſy way of making it. For whereas before, thoſe, that went about to diſtil it, commonly uſed, as the apothecaries are wont to do in what they make of the ſame matter, ſhavings or raſpings of hartſhorn, and diſtilled it with a ſtrong and naked fire, the fugitive and ſubtile ſpirits were wont to come over in that plenty, and with that impetuoſity, as to break the glaſſes to pieces, whereby apothecaries, and even chymiſts were diſcouraged from drawing the ſpirit; and they not having it in their ſhops, its virtues remained unknown. Whereupon, conſidering, that if it were only broken on an anvil into pieces of about the bigneſs of one's little finger, beſides that this way of comminution would be far leſs chargeable than raſping, the fumes would not be driven out ſo faſt: and conſidering too, that a violent fire was requiſite, not to diſtil the ſubtile ſpirit, but to drive over the groſs and heavy oil; I thought it was needleſs to take pains to force that over, which not being (that I obſerved) uſed in phyſick, would coſt me further pains to ſeparate it again. And therefore, trying to diſtil hartſhorn, in naked retorts, placed but in ſand, I found I could diſtil two or three pound at a time, and obtain from each of them, almoſt, if not quite, all the ſpirits and volatile ſalt, which I afterwards ſeparated from the reddiſh and lighter oil, and freed them from phlegm and feculencies by a couple of rectifications, made in tall glaſſes, and with very gentle heats, (commonly of a lamp-furnace.) The doſe may be from eight, or ten drops of the ſpirit, or grains of the ſalt, to ſix times the quantity of either, in warm beer, or any vehicle that is not acid, except milk. Finding it to be a medicine of an attenuating, reſolving, and diaphoretical nature, and one that much reſiſts malignity, putrefaction, and acid humours, (whence being mingled with ſpirit of vinegar, and the like ſour juices, it deſtroys their acidity,) I direct it (*præmiſſis univerſalibus*) in fevers, coughs, pleuriſies, obſtructions of the ſpleen, liver, or womb, and principally in affections of the brain, as ſtoppages of the head, feveriſh deliriums, and even *in phrenetide*. And ſince I wrote a good part of this eſſay, I had an experiment of it in a child, who being, by many violent convulſion-fits, reduced to a deſperate condition, was recovered by one doſe of five or ſix drops of this ſpirit that I ſent it. It is true, that I have another medicine, that is more elaborate and coſtly, and more properly bears the name of *eſſentia cornu cervi*, which I more value than this: but I cannot communicate that, without prejudicing a third perſon, and an excellent chymiſt, who makes great advantage of it. But this I can tell you, that moſt of the cures, for which my preparation of hartſhorn hath had the good fortune to be eſteemed, have been performed with the above deſcribed ſimple ſpirit and ſalt, with which ſome ſkilful phyſicians and other ingenious perſons, who had it from me, have within theſe few years ſaved ſo many lives, that I am inclined to think, I have done no uſeleſs piece of ſervice, in bringing ſo happy a medicine into requeſt, eſpecially with thoſe, that have ſkill and opportunity to make better uſe of it than I. But, *Pyrophilus*, I find I have detained you ſo long with ſo prolix a mention of the three above deſcribed remedies, that I ſhould think it requiſite to make you a ſolemn apology; but that I hope your charity will as well invite you to pardon the fault, as mine induced me to commit it.

CHAP. VII.

That mechanicks and other experimental learning may teach how to leſſen the charge of cures, by making more convenient furnaces, demonſtrated in divers particulars.

A FOURTH way of leſſening the charges of cures may be this; that whereas the dearneſs of very many medicines proceeds from the chargeableneſs of thoſe chymical operations, whereby they are wont to be prepared, it is to be hoped, that a greater meaſure of ſkill in phyſiology, and other experimental learning, will ſuggeſt cheaper and better ways of doing many things in chymiſtry, than are, as yet, uſually practiſed.

And thoſe thrifty expedients, I conceive, may be of ſeveral kinds, of which I ſhall at preſent

preſent mention, and that but tranſiently, three or four.

AND firſt, I doubt not but chymiſts may be taught to make better furnaces, for ſeveral purpoſes, than thoſe, that have been hitherto moſt uſed among them. For profeſſed chymiſts having been for the moſt part unacquainted enough with many other parts of learning, and particularly with the mechanicks, their contrivances of furnaces and veſſels have been far enough from being as good, as knowledge in mechanicks and dexterity in contrivances might, and, I doubt not, hereafter will, ſupply them with; whether as to the ſaving of fuel, or to the making the utmoſt uſe of the heat afforded by the fuel they do employ, or as to the intending heat to the height, or as to the regulating heat at pleaſure.

IT is ſomewhat wonderful, as well as pleaſant, to ſee, how many veſſels may be duly heated by one fire (perhaps no greater than common diſtillers employ to heat one veſſel) if the furnace be ſo contrived, as that the flame may be forced to paſs in very crooked and winding channels towards the vent or vents, and the heat may be ſkilfully conveyed to ſeveral parts of the furnace, according to the exigency of the work it is to do. And as for the intention of heat, I remember I have had odd effects of it, by the contrivance of a certain furnace, that held but very few coals, and to which I uſed no bellows. But though, by this way, I could vitrify ſometimes the very crucibles, and thought poſſibly I could, with a ſlight alteration, melt down the ſides of the furnace themſelves; yet a diſciple of *Cornelius Drebell*, and a very credible perſon, aſſured me, that he knew a way of furnaces, that was yet fitter to bring heat to the ſuperlative degree; and that he himſelf, the relator, could by the mere force of fire in his furnace, bring Venetian talc to flow; which is more, I confeſs, than ever I have been able to do, either in mine, or thoſe of the glaſs-houſe. But experience hath aſſured me, it is eaſy to make a furnace give that heat as expeditiouſly enough, and in other reſpects very conveniently to cupel both gold and ſilver, without the leaſt help of bellows. That alſo furnaces may be ſo ordered, as that the heat may be better regulated, than that in our ordinary ones, I may elſewhere ſhew you cauſe to believe; and in the mean time I ſhall only tell you, that I look upon the ſkill of intending and remitting heat at pleaſure, and eſpecially the being able to keep a gentle heat long and equal, as a thing of much greater moment, both as to phyſick and philoſophy, than chymiſts are wont to think, (the powerful effects of conſtant and temperate heats, being as yet known to few, ſave thoſe, that have made trial of them.) And with lamp-furnaces well ordered, divers things may be done in imitation of nature; ſome friends of mine having, as ſeveral of them aſſure me, in ſuch furnaces brought hen-eggs to manifeſt animation. That alſo furnaces may be ſo built, as to ſave much of the laborants wonted attendance on them, may appear by the obvious invention of athanors, or furnaces with towers, wherein the fire is for many hours, (perhaps for twenty-four, or forty-eight) ſupplied with a competent proportion of coals, without being able to burn much faſter than it ſhould. And that in many caſes the labour of blowing may be well ſpared, and the annoyance of mineral fumes in great part avoided by an eaſy contrivance, is evident by thoſe furnaces, which are blown by the help of a pipe, drawing the air, as they commonly ſpeak, either at the top, as in *Glauber*'s fourth furnace, or at the bottom, or for want of room, upwards, I have ſometimes tried. To which may be added, that the caſting of the matters to be prepared upon quick coals, as *Glauber* preſcribes in that, which he calls his firſt furnace, is, in ſome caſes, a cheap and expeditious way of preparing ſome minerals, though his method of making ſpirit of ſalt in that furnace would not ſucceed, according to his promiſe with me, and ſome of my acquaintance. And there are other more commodious contrivances, by caſting ſome things upon the naked fire, which invites me to expect, that there will be ſeveral good expedients of employing the fire to chymical operations, that are not yet made uſe of, nor perhaps ſo much as dreamed of.

AND as furnaces, ſo the veſſels, that more immediately contain the thing to be prepared, are queſtionleſs capable of being made more durable, and of being better contrived, than commonly they are. Good uſe may be made of thoſe earthen retorts, that are commonly called *Glauber*'s ſecond furnaces, in caſe they be made of earth, that will endure ſtrong fires, and in caſe there be a better way to keep in the fumes, than that he propoſes of melted lead, which I have therefore often declined for another, as having found it liable to ſuch inconveniences as I elſewhere declare.

BUT for materials that are cheap, and to be diſtilled in quantity, as woods, hartſhorn, *&c.* the way is not to be deſpiſed, and is, as we may elſewhere have occaſion to ſhew, capable of improvement; though in ſome caſes this kind of veſſel is inferiour to thoſe tubulated retorts, that were of old in uſe, and mentioned by *Baſilius Valentinus*, and from which *Glauber* probably deſumed that, which we have been ſpeaking of. The utility of the way of ſealing glaſſes hermetically, and of the invention, that now begins to be in requeſt, of ſtopping the bottles, that contain corroſive and ſubtile liquors with glaſs ſtopples, ground fit to their necks, inſtead of corks, together with ſome other things, not now to be mentioned, keep me, that I ſcarce doubt, but that if we could prevail with the glaſs-men and the potters, to make veſſels of glaſs and earth exactly, according to directions, many things in chymiſtry might be done better and cheaper than now they are; and ſome things may be then done, that with the forms of veſſels now in uſe cannot be done at all. And if that be true, which we find related in *Pliny*, and with ſome other circumſtances in *Dion Caſſius*, of a more ingenious than fortunate man, who, about his time, was put to death for having made malleable glaſs; as the truth of that

Glaſs-ſtopples fitteſt for corroſive liquors.

ſtory, if granted, would ſhew the retrieving that invention a thing not to be deſpaired of; ſo he, that could, now chymiſtry is ſo cultivated, find again the way of making glaſs malleable, would be, in my opinion, a very great benefactor to mankind, and would enable the virtuoſi, as well as the chymiſt, to make ſeveral experiments, which at preſent are ſcarce practicable: and ſome chymiſts would perhaps think the attempt more hopeful, if I tell them firſt, that I remember *Raymund Lully* expreſly reckons it among three or four of the principal virtues he aſcribes to the philoſopher's ſtone, that it makes glaſs malleable; and then, that an expert chymiſt ſeriouſly affirmed to me, that he met with an *adeptus*, who, among other ſtrange things, ſhewed him a piece of glaſs, which the relator found, would endure and yield to the hammer. But what my own opinion is concerning this matter, and what are the (uncommon) inducements I have to be of it, I muſt not here declare.

AND on this occaſion, I remember I have ſeen an inſtrument of tin or pewter, for the drawing of ſpirit of wine (which you know is one of the chargeableſt things that belongs to chymiſtry) ſo contrived, that whereas in the ordinary way much time, and many rectifications are requiſite to dephlegm ſpirit of wine; one diſtillation in this veſſel will bring it over from wine it ſelf, ſo pure and phlegmleſs, as to burn all away. And I remember, that the ancient French chymiſt, in whoſe laboratory I firſt ſaw one of theſe inſtruments, told me, that it was invented not by any great alchymiſt or mathematician, but by a needy Pariſian chirurgeon. And now I ſpeak of ſpirit of wine, I ſhall add, that as the charges of chymiſtry would be very much leſſened, if ſuch ardent ſpirits could be had in plenty, and cheap; ſo I think it not improbable, that in divers places there may be found, by perſons well ſkilled in the nature of fermentation, other vegetable ſubſtances far cheaper than wine, from which an inflammable and ſaline ſulphureous ſpirit, of the like virtue, for diſſolving reſinous bodies, drawing tinctures, *&c.* may be copiouſly obtained. For not only it is known, that cider, perry, and other juices of fruits will afford ſuch a ſpirit; and that moſt grains, not very unctuous, as barley, wheat, *&c.* will do the like, but other berries, that grow wild, as thoſe of elder, will yield a vinous liquor. And in the *Barbadoes* they make a kind of wine, even of roots, (I mean their *Mobby*, which they make of potatoes; as I have alſo, for curioſity's ſake, made bread of the ſame roots;) nay, even ſome ſorts of leaves, ſuch a liquor may be obtained. For I have obſerved roſes, well fermented, to yield a good ſpirit very ſtrongly taſted, as well as inflammable. And as to the preparing of pure ſpirit of wine it ſelf, I know ways (and one of them cheap) that may exceedingly ſhorten the time, and pains of dephlegming it: but that being to be done otherwiſe, than by any peculiar contrivance of furnaces or glaſſes, I reſerve it for a fitter place, in one of the following eſſays.

That inflammable ſaline ſulphureous ſpirits may be drawn from other ſubſtances cheaper than wine.

AND as more expedient and thrifty ways than the vulgar ones, of making chymical furnaces and veſſels, may be deviſed; ſo it is to be hoped, that a ſkilful naturaliſt may find cheaper ways of heating the chymiſt's furnaces, or diſtilling in his veſſels, (either by finding combuſtible materials, not formerly in uſe in the places where we work, or by making thoſe already imployed fitter for uſe) by bringing them, by ſome cheap alterations, either to give a greater, or a more durable heat; or to be leſs offenſive by their ſmokes or ſmells; or elſe by diſcovering ſome cheap way of doing, in ſome caſes, without fire, what was wont to be done by it.

Inſtances in divers particulars, how the naturaliſt may find cheaper ways of heating the chymiſts furnaces.

WE ſee, that in ſome places, eſpecially here in *England*, where charcoal was only burnt in furnaces, pit-coal is ſubſtituted in its room. And at this day there are ſeveral of thoſe, that make aqua fortis in great quantities, that diſtil it with ſuch coals, which coſt nothing near ſo much as thoſe made with wood. And experience hath informed me, that even in other ſorts of furnaces, the ſame fuel may be employed, provided the bars of the grates be ſet wider aſunder, and a little charcoal be mingled with it for the better kindling: and ſince of late years pit-coal have been found in ſeveral places among us, where they were not formerly known to be, it ſeems not improbable, that many other countries may afford chymiſts, and the reſt of their inhabitants, the like advantage, if ſearch were duly made, by boring of the ground, by the obſervations of the waters, and the ſteams of places ſuſpected, and by other ways of inquiry, that a ſkilful man might direct. But becauſe the abundant ſmoke of pit-coal uſes to be very offenſive, and the ſmaller coals eaſily run through the grates, and becauſe of other inconveniences, there hath been a way found out of charring theſe coals, and thereby reducing them into coherent maſſes, of a convenient bigneſs and ſhape, and more dry and apt to kindle. And theſe, though quantity for quantity, their price be little inferiour to that of charcoal, yet thoſe, that conſume great proportions of coals, tell me they find them almoſt as cheap again, in regard they will not only laſt much longer, but give (eſpecially near at hand) a far more intenſe heat. And therefore it muſt be a very uſeful thing to chymiſts, to ſhew a way of charring ſea-coals, without the help of thoſe pots, which make them of the price they now bear. And that it is not only poſſible, but very eaſy, I could quickly ſhew you, if it would not prejudice an induſtrious laborant, whoſe profeſſion being to make chymical medicines in quantity, obliges him to keep great and conſtant fires, and did put him upon finding a way of charring ſea-coal, wherein it is, in about three hours or leſs, without pots or veſſels, brought to charcoal; of which having, for curioſity ſake, made him take out ſome pieces, and cool them in my preſence, I found them upon breaking to appear well charr'd, and much thereof in ſhew not unlike a marcaſite. And that, which was very convenient in this contrivance, was, that whilſt the pit-coal was charring, it afforded him a very intenſe heat to melt or calcine the minerals, he had

Of charring coals, ſo that while it chars, it gives an intenſe heat, fit to melt or calcine minerals.

had occaſion to expoſe to it: And he confeſt to me, that by this method, he ſaved three parts in four of the charges the keeping ſuch great and conſtant fires, with common charcoal, would coſt him. In *Holland* likewiſe, they have a way of charring peat, (which is a combuſtible turf, that they dig under ground;) and a ſkilful diſtiller, that much employed it, commends it to me, as a very good fuel, even for chymical fires: which I therefore mention, becauſe the way of charring peat is not yet brought into ſeveral countries, where peat is digged up; and probably, it would be found in divers regions, where it is yet unknown, if due ſearch were made for it. To which I may add, that it is not unlike, that ſome countries may afford ſuch combuſtible materials fit for chymical furnaces, as have not, as yet, been ſo much as named by mineraliſts: as I remember I have ſeen, and had, a ſort of coals, ſome of which looked like marchaſites, that burned clear with a good flame, and had this convenient quality for the chymiſt's uſe, that they were not apt, like the common pit-coals, to ſtop the grates with their cinders, but burnt to whitiſh aſhes, almoſt like charcoal made of wood; and yet gave ſo great a heat, that an induſtrious chymiſt of my acquaintance, who kept many things conſtantly at work, found it worth while to have them brought him, above a day's journey, on horſes backs.

Of charring peat.

BUT it is not impoſſible, that when men grow better naturaliſts, they may find ways of exciting heat, enough for many chymical operations, without the help of fire, and conſequently, without the conſumption of fuel. We find, that by the attrition of hard bodies, conſiderable degrees of heat may be produced, not only, in combuſtible materials, as wood, and the like, (which would therefore be improper to be here inſiſted on;) but in others alſo, and particularly in iron and ſteel, one may by attrition ſoon produce a ſmart heat, as you may quickly try, by nimbly filing a piece of iron, with a rough file, or ſwiftly rubbing, though but a few minutes, a thin piece of ſteel againſt a board. And whether ſome contrivance may not be found, by the help of cheap engines moved by water, or otherwiſe, to produce a durable heat in iron veſſels, fit to digeſt in, we may elſewhere have farther occaſion to conſider; but this is known, that from ſome ſucculent plants a liquor may be drawn, only by expoſing them in glaſſes, purpoſely contrived, to the beams of the ſun. And there is nothing more common, than for chymiſts to make their digeſtions by the warmth of horſe-dung, whereby they might alſo (as ſome analogous trials incline me to think) conveniently enough diſtil ſome fermented liquors; eſpecially if the way were improved by the ſkilful addition of quick-lime, and ſeaſonable aſperſions of water. And I doubt not, but many cheap materials might, by a few trials, be found, whereby portable digeſting furnaces, without fire, (if I may ſo call them) might be made, without the the ill ſmell and naſtineſs, which diſcommends the uſe of horſe-dung. For not only we ſee, by what happens in the ſpontaneous heating of malt, and ſome other familiar ſubſtances, that probably moſt ſorts of grains and berries, fit for fermentation, may be brought to yield, for a good while, a heat great enough to putrify or digeſt with: but I have, ſeveral years ago, by many trials found, that I could, by invironing glaſſes with refuſe hay, well preſſed down, and equally wetted throughout, produce for divers days ſuch a heat, as made me decline the employing of horſe-dung; and yet (which is the chief thing, for which I mention this) the quantity of hay was ſo ſmall, that in all my trials I found not, that the hay did of it ſelf, though kept cloſe enough, take fire, as elſe is uſual in ricks of hay not ſufficiently dried, where the quantity, and conſequently the weight, that preſſes the lowermoſt parts cloſe together, is conſiderable.

Of digeſtion and diſtillation without fire.

BUT farther, in divers operations, where an actual fire is requiſite, it may be hoped, that knowing men may diſcover ways of ſaving much of the fire, and making ſkill perform a great part of the wonted office of heat. To obtain the ſpirit of freſh urine, you muſt diſtil away near nine parts of ten, which will be but phlegm, before the ſpirit or volatile ſalt will (and that ſcarce without a pretty ſtrong heat) regularly riſe. And there are ſeveral chymiſts, that to this day make uſe of no better way of diſtilling urine; but he, that knows, how putrefaction opens many bodies, may eaſily ſave himſelf the expence of ſo much fire. For if you let urine ſtand well ſtopped, for eight or ten weeks, the ſaline and ſpirituous parts will ſo extricate themſelves, that the ſpirits, that before ſtayed behind the phlegm, will now, even with the gentleſt heat, riſe up firſt, and leave the phlegm behind. And on this occaſion I ſhall teach you, what I do not know to have been mentioned by any writer; namely, that even of freſh urine, without digeſtion or putrefaction, I can, by a very cheap and eaſy way, make ſubtile and penetrant ſpirit aſcend, firſt, even in a gentle heat. And I am wont to do it, only by pouring urine, how freſh ſoever, upon quick-lime, till it ſwim ſome fingers breadth above it, and then diſtilling it as ſoon as I pleaſe. But I did not find, upon many trials, that this ſpirit, though even without rectification very ſtrong and ſubtile, would coagulate ſpirit of wine, like that of putrified and fermented urine; though perhaps for divers other purpoſes it may be more powerful.

Ways of diſtilling ſpirit of urine.

Of diſtilling it with lime without fermentation.

That ſo diſtilled, it doth not coagulate ſpirit of wine, as in the uſual diſtillation.

AND here I ſhall advertiſe you, that whereas I juſt now took notice, that there was a pretty ſtrong fire requiſite to force up the ſalt of unfermented urine out of that part, which, after the abſtraction of the phlegm, remains of the conſiſtence of honey; trial hath informed me, that the volatile ſalt may out of the thick liquor be obtained, better and more pure, with eaſe, and with a ſcarce credibly ſmall heat, barely by tempering the urinous extract with a convenient quantity of good wood-aſhes, whereby (for a reaſon elſewhere to be conſidered) the volatile part of the ſalt of urine is ſo freed from the groſſer ſubſtance, that with ſtrange facility it will aſcend fine and white, to the top of very tall glaſſes. But of the differing

ing preparation of urine, more perhaps elſewhere. I now proceed to tell you, that I think it not unlikely, that even bodies, which are more groſs and ſluggiſh, may, by the affuſion of ſuch menſtruums, as human induſtry may find out, be far more eaſily, either, volatilized or unlocked, than common chymiſts are wont to think. For I know a liquor, not very rare among chymiſts, by whoſe help I have, often enough, diſtilled ſpirit of nitre (whoſe diſtillation requires much about the ſame violence of fire with that of aqua fortis) even in a moderate heat of ſand, and without a naked fire. This ſpirit may eaſily enough be brought over, even in a head and body: and for a wager, I could obtain a little of it without any fire or outward heat at all. And I remember alſo, that having once digeſted a certain menſtruum, for a very ſhort time, upon crude antimony, and abſtracted it, in a very gentle heat of ſand; the liquor not only brought over ſome of the antimony in the form of red flowers, ſwimming in it, and united other parts of the mineral, with it ſelf, in the tranſparent liquor; but the gentle heat raiſed to the top of the retort divers little maſſes of a ſubſtance, that were very tranſparent, like amber, which were inflammable, and ſmelt, and burnt blue, juſt like common ſulphur: and yet the menſtruum, which was eaſily again recoverable from the antimony, was no ſtrong corroſive, taſting, before it was poured on, not much unlike good vinegar.

Of the power of good menſtruums in facilitating diſtillation.

But beſides all the ways above mentioned of ſaving the chymiſt either time, or fire, or labour; I deſpair not, that divers others, yet unthought on, will be in time found out by the induſtry of ſkilful men, taking notice of the nature of things, and applying them to chymical uſes; as we ſee, that by amalgamations with mercury, the calcination of gold and ſilver may be much eaſier performed, than by a long violence of fire. And (if it be true, what *Helmont* and *Paracelſus* tell us, of their immortal liquor alkaheſt) medicines far nobler, and otherwiſe more difficult to make, than thoſe hitherto in uſe among the chymiſts, may be prepared with greater eaſe, and expedition, and with far leſs expence of fire, than the nature of the metals, and other concretes to be opened by it, would let a vulgar chymiſt ſuſpect. However, I ſee no great cauſe to doubt, that there may be menſtruums found, that will much facilitate difficult operations; ſince, not to mention again the liquor I lately told you would work ſuch a change on nitre, (and, I might have added, on ſome other compact bodies,) it is very like, there may be menſtruums found, that will not be ſo ſpoiled by a ſingle operation, made with them, as our vulgar ſaline ſpirits are wont to be. For I have tried, that a menſtruum, made by the bare diſtillation of good verdigreaſe, will not only draw, as I have formerly told you, a tincture of glaſs of antimony, or perform ſome other like operation for once, but being drawed off from the diſſolved body, or the extraction, will again ſerve, more than once, for the like operation upon freſh materials.

That the calcination of gold is facilitated by amalgamations with mercury.

The power of verdigreaſe diſtilled in drawing tinctures of glaſs of antimony, &c.

The fifth, and laſt way, *Pyrophilus*, that I intend to mention, of leſſening chymical expences, is, that the naturaliſts may probably find out ways of preſerving ſome chymical medicines either longer or better than thoſe ways that are uſual. But of this preſervation of bodies being like, as I formerly intimated, to have elſewhere further occaſion to treat; I ſhall now only ſay, that the purified juices, liquid extracts, robs, and other ſoft medicaments, made of plants, may be conſerved far cheaper, as well as better than with ſugar, (which clogs moſt men's ſtomachs, and otherwiſe diſagrees with many conſtitutions) in caſe *Helmont* ſay true, where he tells us, that for a ſmall piece of money he can, for I know not how long, preſerve whole barrels of liquor. And a way he intimates, of fuming liquors with ſulphur, I have already told you, is a very good way of keeping them uncorrupted; provided, that (though he preſcribes it not) they be ſix or ſeven ſeveral times (ſeldomer or oftener, according to the quantity or nature of the liquor) well impregnated with that imbalming ſmoke; to which purpoſe it is convenient to have two veſſels, to pour from one to the other, that whilſt the liquor is ſhaking in the one, the other may be well filled with ſmoke. Whereto I ſhall only ſubjoin this ſecret, which a friend of mine practiſes, in preſerving the fumigated juices of herbs, (as I elſewhere inform you, I do to preſerve other things) with a ſucceſs, that I have ſomewhat wondred at; which conſiſts, in adding to the thick liquor to be preſerved, a due, but ſmall proportion of the white coagulum, (which I elſewhere mention) made of the pure ſpirits of wine and urine.

That the naturaliſt may find out ways to preſerve medicines longer and better than is uſual.

Of fuming liquors with ſulphur.

And adding a little of the white coagulum made of the pure ſpirits of wine and urine.

But I have made this excurſion too prolix, and therefore I ſhall only add as a general admonition, that we are not, by the common practice of vulgar chymiſts, to eſtimate what knowing naturaliſts, ſkilled in mechanical contrivances, may be able in time to do, towards the making chymical remedies, as well more cheap as more effectual: and indeed, to make them more effectual, is the beſt way to make them more cheap.

For, *Pyrophilus*, after all the ways, that I have mentioned, whereby the charges of the therapeutical part of phyſick may be leſſened; I muſt advertiſe you, both, that I make no doubt, but that there may be others found, which either through want of ſkill or leiſure I have pretermitted, and that I have not yet named the principal of all; which is, that the deep inſight into natural philoſophy may qualify him, that hath it, by ſeveral ways, and eſpecially by diſcovering the true cauſes and ſeats of diſeaſes, to find out ſuch generous and effectual remedies, (whether ſpecifick, or more univerſal arcana) as by quickly freeing the patient from his diſeaſe, may exempt him from needing either much phyſick from the apothecary, or many chargeable viſits from the doctor, or chirurgeon. Thus the rich merchant I mentioned, in one of the former eſſays, to have been freed, by a ſpecifick, from the gout; and the young Lady cured of her fiſtula's, by the infuſion of millepedes;

That the moſt principal way of leſſening the charge of cures would be the finding out new and more effectual remedies.

might

might well, in the ordinary way, have ſpent, even ſuppoſing them thrifty, an hundred times more upon phyſicians and phyſick, than the potent and nimble remedies, whereby they were ſo happily recovered, coſt them.

[To which I ſhall add, by way of confirmation, both of this, and of what I lately told you, concerning the efficacy, that may be, even in ſlightly prepared ſimples, what I came to learn, ſince the writing of the former part of this eſſay; namely, that a young lady, who (though of great birth, is yet of far greater beauty and virtue, whom I preſume I need not name to you) having been long troubled with an almoſt hereditary epileptical diſtemper, and after having been wearied by courſes of phyſick preſcribed her by the famouſeſt doctors, that could be procured, without at all mending but rather growing worſe, ſo that ſometimes, ſhe would have, in one day, eight or ten of ſuch diſmal fits, as you and I have ſeen her in; was cured only by the powder of true miſletoe of the oak, given as much as would lie upon a ſix-pence, early in the morning, in black cherry-water, or even in beer, for ſome days near the full moon. And I am aſſured, partly by the patient herſelf, and partly by thoſe, that gave her the medicine, that though it had ſcarce any other ſenſible operation upon her, and did not make her ſickiſh, eſpecially when ſhe ſlept upon it; yet after the firſt day ſhe took it, ſhe never had but one fit. And this remedy an ancient gentleman, who, being caſually preſent, when ſhe ſuddenly fell down as dead, gave it her, profeſſed himſelf to have conſtantly cured that diſeaſe with it, when he could procure the right ſimple, which is here exceeding ſcarce. And what further experiment ſome friends of yours have ſucceſsfully made, I may elſewhere have occaſion to relate.]

An hiſtory of a radicated epilepſy, that was cured by the powder of miſletoe of the oak.

To which I ſhall only add, that one of the ſkilfulleſt methodiſts I ever knew, having had much ado to preſerve a young couſin of yours from a very dangerous cough, by a long courſe of phyſick; the party, at the beginning of the next winter, falling into a relapſe more threatning than the firſt diſeaſe, was reſcued from it in two or three days, by not many more takings of a ſpecifick ſent her, made of nothing elſe but hartſhorn prepared, as I lately taught you. And if ſuch ſlight medicines, conſiſting, each of them, but of a ſingle ſimple, not elaborately prepared, may ſometimes (for I ſay not always) perform ſuch ſpeedy cures even in chronical diſtempers; what may not be hoped from the *arcana majora* (ſuch as *Paracelſus*'s *Laudanum*, ſo praiſed by *Oporinus* himſelf, and *Butler*'s *Driff*, ſo extolled by *Helmont*) when the ſkilfulleſt preparations of the nobleſt ſimples ſhall come to be known by learned and judicious men, intelligent in the theory of phyſick, and eſpecially verſed in the hiſtory of diſeaſes? And though *Riverius* were none of the greateſt naturaliſts, or, at leaſt, chymiſts; yet if in his *Obſervations*, and elſewhere, he flatter not his own *Febrifugum*, how many patients did that one ſpecifick reſcue from quartans, that would elſe probably have proved as chargeable as tedious?

BUT, *Pyrophilus*, having ſaid ſo much, that I fear you have thought it tedious, to ſhew, that a naturaliſt, ſkilled in chymiſtry and the mechanicks, may aſſiſt the phyſician to make his cures leſs chargeable, it is high time, that after ſo long an excurſion, I proceed to conſider, in what other particulars he may be a benefactor to the phyſician's art.

CHAP. VIII.

FIFTHLY, then, that the naturaliſt's ſkill may improve the pharmaceutical preparations of ſimples, by ſeveral ways partly touched already, and partly to be, either, added or farther treated of; the great variety of new remedies, wherewith the laboratories of chymiſts have furniſhed the ſhops of apothecaries, may convincingly inform you. To which I muſt take the liberty to add, (and that upon ſerious conſideration,) That *the chymical preparations, hitherto common in Diſpenſatories, are, as to the generality of them, far enough from being the moſt dextrous, or noble, that can be deviſed.* For our vulgar chymiſtry (to which our ſhops owe their venal ſpagyrical remedies) is as yet very incomplete, affording us rather a collection of looſe and ſcattered (and many of them but caſual) experiments, than an art duly ſuperſtructed upon principles and notions, emergent from ſevere and competent inductions, as we have elſewhere endeavoured more particularly to manifeſt. And therefore, till the principles of chymiſtry be better known, and more ſolidly eſtabliſhed, we muſt expect no other, than that very few vulgar chymical remedies ſhould be of the nobleſt ſort; and that in the preparation of many others, conſiderable errors ſhould be wont to paſs unheeded, and faults groſs enough, be apt to be miſtakenly committed. But of this ſubject we may elſewhere have divers occaſions to entertain you; and our ſingle eſſay, *of the Chymical Diſtinctions of Salts*, will perhaps diſcover to you no ſmall miſtakes, in the preparation of divers applauded vulgar medicines. For it is not the elaborateneſs, but the ſkilfulneſs of preparations, that produceth the noble remedies; and a few teeming principles well known and applied will enable a man with eaſe to make better remedies, than a great many furnaces and glaſſes, though never ſo well contrived, and though very uſeful in their kind. To make this out in ſome meaſure, I ſhall name ſome ſuch inſtances, as may withal confirm what I formerly delivered in this eſſay, touching the poſſibility and uſefulneſs of correcting either poiſonous, or otherwiſe very noxious ſimples. I never knew opium ſo much corrected by ſaffron, cinnamon, and other aromatical and cordial drugs (wherewith it is wont to be made up into laudanum) nor by the moſt tedious tortures of *Vulcan*, as I have known it by being a while digeſted in wine, impregnated with nothing, but the weight of the opium of pure ſalt of tartar, as we elſewhere more fully declare. (A much nobler laudanum may be made by adding to the opium, inſtead of the ſalt, two or three appropriated ſimples, and by due fermentations and digeſtions of them with it.) And for that

Other proofs, that the naturaliſt's skill may improve the pharmaceutical preparation of ſimples.

Of the beſt ways to correct opium.

violent vomiting-medicine, by chymiſts flatteringly enough called *mercurius vitæ*, a whole pound of cordial conſerves, or liquors, will not ſo well moderate its evacuating force, as the keeping it continually ſtirring in a flattiſh and well-glazed earthen veſſel, placed over a chafing-diſh of coals, till it emit no more fumes, but grow of a greyiſh colour: which I am very credibly informed to be the preparation of *mercurius vitæ purgans*, oftentimes mentioned and commended by the famous practitioner *Riverius*, in his *Obſervations*. A not unlike, but far more ſudden, correction of that active powder, I elſewhere teach. And as for thoſe operative minerals, quickſilver, and antimony, though long experience of their churliſh and untractable nature has made many of the warier phyſicians and chymiſts ſhy to meddle with either of them ſingle; yet theſe concretes, which ſeem ſo incorrigible, may, by being barely (in the gradual diſtillation of butter of antimony) ſublimed up together in a cinnabar, and then that cinnabar, ſix or ſeven times reſublimed *per ſe*, be united into a medicine, that not only is not wont to work, either upwards or downwards, but of which I have known ſafely taken, even in ſubſtance, to the doſe of many grains; and a few drachms of which, infuſed in a pound or two of wine, hath made it of that inoffenſive efficacy (taken, in the quantity of a ſpoonful or two, daily upon an empty ſtomach) that, if it ſtill ſucceed as well as we have obſerved it two or three times to do, we may think, that our having thus acquainted you with the virtue of this unlikely remedy, (though we have alſo met with it, even in printed books) may make you amends for all the reſt of this tedious diſcourſe. I once knew a ſlight (but altogether new and tedious, as well as philoſophical) preparation of ſalt of tartar correct and tame ſuch poiſons, as ten times the quantity of the higheſt vulgar antidotes, or cordials, would (I was confident) ſcarce have ſo much as weakened: and I have known by the ſame prepared ſalt, dexterouſly ſpecificated by ſimples, the virtues of ſome vegetables ſo exalted, that, without any cathartick or emetick operation, they have (if many patients, of whom I had caſual opportunities to inquire of the effects of thoſe remedies upon them, do not miſ-inform me) proved more effectual in taming divers ſtubborn diſeaſes, than *crocus metallorum*, *mercurius vitæ*, (as it is abuſively called) and thoſe other dangerous remedies, which make the vulgar wont to ſay of chymiſts, that they quickly either cure their patients, or kill them. And to let you ſee, *Pyrophilus*, by one plain, and yet noble inſtance, that the knowledge of the ſpecifick qualities of things, ſkilfully applied to preparations, may perform, with eaſe, what neither coſtly materials, nor elaborate proceſſes are able to effect; give me leave to inform you, that, whereas chymiſts and phyſicians have not been able by infuſing the true glaſs of antimony (made *per ſe*) in ſpirit of wine, or the richeſt cordial liquors, nor yet by torturing it after ſeveral tedious and artificial manners, to deprive it of its emetick quality; that vomitive faculty, of antimonial glaſs, may be corrected by ſo ſlight a way, as that of digeſting it with pure ſpirit of vinegar, till the menſtruum be highly tinged. For if you gently abſtract all the liquor, and on the remaining yellow or red powder you digeſt well dephlegmated ſpirit of wine; you may after a while obtain a noble and not emetick tincture; of which though *Baſilius Valentinus* preſcribes but five or ſix drops for a doſe, yet a domeſtick of mine having, out of curioſity, taken to the quantity of thirty drops at a time, he found it not at all vomitive. And this tincture we the rather mention, becauſe, not only *Baſilius Valentinus*, but other ſkilful perſons, highly extol it for ſeveral diſeaſes.

Of the beſt way of correcting of mercurius vitæ.

An excellent medicine made of thoſe churliſh minerals, quickſilver and antimony.

Ways to take away the vomitive faculty of antimonial glaſs.

See his Currustriumphalis antimonii.

And let me add, *Pyrophilus*, (and be pleaſed to mark well what I tell you) that by bare reiterated digeſtions, and fermentations, there may be prepared, out of many vegetables, ſaline and ſulphureous eſſences (whoſe bulk is exceeding ſmall, in proportion to the concretes whence they are extracted) which will keep many years, as I can ſhew you ſome above three years old, and contain more of the craſis (if I may ſo call it) of the ſimple, than the vulgar vegetable waters, ſpirits, extracts, or ſalts, hitherto extant in laboratories and ſhops. But there is ſo great a length of time required to the preparation of theſe efficacious juices, that my ambulatory condition of life hath not allowed me to furniſh my ſelf with many of them.

And, *Pyrophilus*, if you will not diſbelieve a perſon, for whom you have ſo juſt an eſteem, as you have for that ingenious, and experienced, Monſieur *L. F.* who was the French King's chymiſt, when you knew him at *Paris*; I can preſent you with a yet nobler inſtance, to perſuade you, that, if ſkill be not wanting, a ſingle herb, without any violence of fire, may, by other ways, than are in uſe among chymiſts, be eaſily enough brought to afford medicines, endowed with ſome nobler virtues than any of the moſt compounded, coſtly, and elaborate medicines, whether minerals or others, that are to be met with among vulgar chymiſts. This efficacious part of the plant, whence it is obtained, *Paracelſus* calls the *primum ens* of the plant, that yields it: but though, indeed, I have found the way of preparing it much plainer, and better delivered, than is uſual in his writings, at the end of his book *De Renovatione & Reſtauratione*; yet I freely acknowledge, that I ſhould ſcarce have thought it worth the trial, if it had not been for what the experienced chymiſt above-mentioned affirmed to me, upon his own obſervations, concerning it, partly, becauſe I am not wont to be forward, ſo much as to try long proceſſes upon *Paracelſus*'s credit, and partly, becauſe what he calls *Sal Solutum*. ſeemed to me ſomewhat ambiguous. Since in the ſame page, teaching to draw the *Ens primum* of gold and antimony, he makes not uſe of ſea-ſalt, but of (a ſalt of an incomparably higher nature) his *Sal circulatum:* and in the proceſs immediately preceding ours, to make the *Ens primum* of emeralds, he preſcribes the calcining them *in ſale ſoluto*, which agrees far better with his *Sal circulatum*, than with any ſolution

A new and excellent way to get the primum Ens, or eſſence, of ſome vegetables.

ſolution of ſea-ſalt; which ſeems very unlikely to be able to calcine, and, as he ſays it muſt, diſſolve emeralds. But the way, that our French chymiſt told me he uſed, was in ſubſtance this: Gather, in a convenient ſeaſon and time of day, balm, for inſtance, or ſome other fit herb, (for experience hath taught, both him and me, that all herbs are not fit, by this way, to be reduced into liquors) and having beaten it well, in a marble mortar, to a ſoft maſh, placed in a bolt-head hermetically ſealed, to digeſt forty days in a dunghill, or ſome analogous heat; then, opening the veſſel, take out the matter, which will be far more liquid than before, from which, having ſeparated the groſſer parts, you muſt digeſt it in a gentle bath, that the yet remaining groſſer parts may ſubſide; to which, being filtrated, you muſt, according to him, (for I find not that *Paracelſus* requires it) join the fixed ſalt of the groſſer parts above mentioned, dried and calcined. To this prepared liquor, you muſt add equal parts of the liquor of good ſea-ſalt well purified, and then melted, and ſuffered to run *per deliquium*. This liquor, being alſo ſealed up in a convenient glaſs, muſt be expoſed to the ſun for about ſix weeks; at the end of which time there will ſwim at the top of it the *primum Ens* of the plant in a liquid form, tranſparent, and either green or red, or, perhaps, of ſome other colour, according to the nature of the plant. And though *Paracelſus* preſcribes but celandine, and balm, to be uſed, yet having inquired of our chymiſts, he told me, he had made ſuch *prima Entia* of ſcrophularia, and, as I remember, of one or two other herbs. But that, which makes me thus, particularly, take notice of theſe kind of medicines, is, that not only *Paracelſus* aſcribes to the *primum Ens* of balm, (or celandine) the power of renovating them, that uſe ſo much of it in good wine as will give it a tincture, early every morning; till, firſt of all the nails of their fingers, then thoſe of their toes, afterwards their hair, and teeth, fall off; and laſtly, the ſkin be dried and exchanged for a new one. But your ingenious acquaintance aſſured me ſeveral times, and once in the preſence of a famous phyſician, and another virtuoſo, to whom he appealed, as knowing the truth of what he ſaid; that an intimate friend of his, whom he named to me, having, after the above mentioned manner, prepared the *primum Ens* of balm, to ſatisfy himſelf the better of its effects, made the trial upon himſelf, and took of it, according to the preſcription, for about a fortnight: long before which his nails, both of hands and feet, began to looſen themſelves from the ſkin, (but without any pain) which at length falling off, of their own accord, this gentleman keeps yet by him in a box for a rarity; but would not purſue the trial any further, being ſatisfied with what he had found, and being in no need of ſuch phyſick. But having given of the ſame medicated wine, for ten or twelve days, to a woman, that ſerved in his houſe, and was near ſeventy years of age, without letting her know, what he expected it ſhould do; her *purgationes menſtruæ* came upon her again in a ſufficiently great quantity to frighten her ſo much, that he durſt proſecute the experiment no further. And when I aſked, why he made no trial upon beaſts; it was anſwered, that though he had but little of the medicine, yet he put apart an old hen, and moiſtening her food with ſome drops of it for a week, about the ſixth day ſhe began to moult her feathers by degrees, till ſhe became ſtark naked: but before a fortnight was paſt, ſhe began to regain others, which when they were come to their full growth, appeared fairer, and better coloured than the firſt: and he added, that, beſides that her creſt was raiſed, ſhe alſo laid more eggs, than ſhe was wont. And as to the *primum Ens* of the greater *ſcrophularia*, by the relator himſelf, though he aſcribed not to it any renovating power, as to that of balm or celandine; yet he aſſured me, he had found it ennobled by other great and extraordinary virtues. But of this kind of preparation, I might ere now poſſibly have been able to give you a better account, if, in my trials about them, I had not met with ſome unhappy accidents, which I hope my next attempts will eſcape: which if they do, I may poſſibly, with an account of them, ſend you one of ſome attempts to prepare the like medicines another and ſhorter way, together with a conſideration, whether *Paracelſus* and others deſervedly call ſuch accidents, as the above-mentioned change of nails, hair, and even of teeth, a real renovation or rejuveniſcence.

The influence of theſe prima Entia to cauſe renovation or rejuveniſcence.

IT is likewiſe a way of preparation, differing enough from thoſe, that are common among chymiſts, which *Helmont* (as he ſays out of commiſeration to the ſick) delivers, where he teaches that, which he calls the *Via Media* of making the *Elixir Proprietatis*, of which he gives us this commendation: *Hoc medicamine tam quartanam, quàm continuam ſtatim abſolvi. Adeò ut qui nectu ſuſceperat ſacroſanctum viaticum, & olei extremam unctionem, me in prandio convivam circa lectum habuerit.* And though many think, that he has rather fraudulently than rightly ſet the proceſs down; yet experience has invited me to abſolve him in this particular. (Though I muſt tell you, that becauſe a languid heat is not ſufficient to make a ſpirituous liquor aſcend, and circulate as he requires; it is not every chymiſt, that will, eſpecially in his firſt trials, avoid the breaking of the glaſſes, or at leaſt the burning of the materials, to which accidents this preparation is very obnoxious, if it be not as well watchfully as ſkilfully made.) And though for my part I have ſcarce uſed this elixir but as a cordial; yet I know ſome very expert phyſicians, that have given it with great ſucceſs in divers difficult caſes, and particularly a friend of the younger *Helmont*'s gives it ſo ſucceſsfully, that partly his patients, and partly others, that have tried it, have ſometimes taken of him, at a great rate, whole pounds in a year or two; and yet I know by his own confeſſion, that beſides the ſkill he employs in making it dexterouſly, he adds nothing but one ingredient, to which, I confeſs, I am not apt to aſcribe any conſiderable part of the efficacy of the medicine; which, when made, he

In tractatulo cui titul. Sequuntur quædam imperfectiora, of Helm. Via media of Elixir Proprietatis.

And the perfuming it with muſk and amber.

he ſometimes perfumes by cohobations with muſk and amber.

A commendation of Helmont's medicines.

AND, *Pyrophilus*, that you may not wonder, that I, who think much of *Helmont*'s theory ſcarce intelligible, and take great exceptions at many things in his writings, ſhould yet now and then commend medicines upon his authority; I muſt here confeſs to you once for all, that (always excepting his extravagant piece, *De magnetica vulnerum curatione*,) I have not ſeen cauſe to diſregard many things he delivers, as matters of fact, provided they be rightly underſtood; having not found him forward to praiſe remedies without cauſe, though he ſeem to do it ſometimes without meaſure, and having more than once, either known, or even had conſiderable effects of medicines he commends, which one of the happieſt practitioners I have met with, and one not laviſh in extolling chymical remedies has ſolemnly aſſured me, he has generally, though not always, found more than ordinarily effectual. And upon occaſion of this odd preparation of the *Elixir Proprietatis*, I ſhall add, that, ſince experience ſhews us, by what is daily done in chymical laboratories, that upon the operation of the fire upon ſeveral concretes, ſubſtances of nature oftentimes very differing both from the body, that afforded them, and from one another, may be obtained; as the oils, and fixt ſalts even of cold plants, or hot; ſince alſo, by the mixture of active bodies new concretes, endowed with new qualities, may be produced; as we ſee, that *ſaccharum Saturni* emergeth from the conjunction of lead, with the acid ſalt, diſtilled vinegar; and ſince the ſame concrete, according to the differing manners, after which it is handled, may acquire differing qualities, as is clear in the various medicines, afforded us by quickſilver, and by antimony, according as each of them is ordered; I cannot but think, that if chymiſtry did no more than aſſiſt us, by the reſolution of bodies, to extricate their more active parts, and partly by ſuch reſolutions, and partly by aſſociating bodies together, to alter the former texture of nature's productions, or preſent us with new concretes of new textures; by this very means, if men want not curioſity, and induſtry to vary and proſecute experiments, there muſt neceſſarily ariſe ſuch a ſtore of new and active medicines, that, in all probability, many of them will be found endowed with ſuch virtue, as have not been, at leaſt in that degree, met with in the uſual medicines, whether ſimple or compound, to be bought in apothecaries ſhops; and conſequently, even without any notable diſcovery, or improvement of principles, chymiſts (even as matters now ſtand with them) may conſiderably add to the pharmaceutical part of phyſick. But if the operations of chymiſtry were ſeriouſly inquired into, and throughly underſtood, I make little doubt, but by a ſkilful application of them, and eſpecially by a ſeries of them, in a rational and orderly way, ſucceeding one another, there may be found out a great many preparations of remedies, both very differing from the common ones, and far more noble than they. And to make this ſeem probable, I need but repeat ſome of the examples formerly mentioned; to which I ſhall add now, that experience has informed me, there is a way, whereby firmer conſiſtent ſubſtances, belonging to the bodies of animals, may, without the addition of any extraneous matter, and without any violence of heat, be reduced almoſt totally into liquor: and if I much miſremember not, theſe liquors, without any violence of heat, afford their ſpirituous and ſaline parts, in a very gentle heat, and that before their phlegm. And I muſt peculiarly inculcate this, that if we had but a few potent menſtruums, to diſſolve and unlock bodies with, I ſcarce know what might not be done in chymiſtry. But when I ſpeak of noble menſtruums, I mean not ſuch, as work like the generality of corroſives, and the like acid or ſaline liquors, which work but upon few kinds of bodies, and ſoon coagulate, or exantlate themſelves by working, and thereby become unfit for future operations; but I mean ſuch, as either are ſeparable with all their efficacy from the diſſolved body; as is ſaid of the alkaheſt, or ſuch ſaline or other piercing liquors, as not being preciſely, either acid, urinous, or alcalizate, can diſſolve a great variety of concretes, without having their virtue, I ſay not impaired, but deſtroyed thereby; and unlock mineral bodies, far more than vulgar menſtruums, (as for inſtance by volatilizing them, or elſe making them irreducible, or working the like grand changes in them;) and if it be not quite ſeparated from the diſſolved body, is yet ſo friendly to human nature, as to be free from either fretting, or other ſuch dangerous and offenſive qualities, and rather to be of it ſelf a powerful medicine. I ſhould therefore exhort both you, and ſuch other ingenious perſons, as wiſh the advancement of chymiſtry, and phyſick, (I might poſſibly add natural philoſophy too) to apply their chymical attempts, chiefly to the finding out of noble menſtruums: for by being poſſeſſor but of one of theſe, a man may be able to do a great number of things, that otherwiſe are not to be performed. As one of our ordinary goldſmiths, by the knowledge he hath of aqua-fortis, can make many uſeful experiments about ſilver and gold, that, before that menſtruum was found out, all of his profeſſion in the world were never able in many ages to compaſs. Nor do I much wonder at that advice, which *Helmont* gives thoſe, that aim at the improvement of phyſick, in theſe words: *Quod ſi ad iſtud ignis arcanum non pertingatis* (he was ſpeaking of a prodigious, not to ſay incredible liquor) *diſcite ſaltem, ſalem tartari reddere volatilem, ut hujus medio veſtras ſolutiones perficiatis. Qui etſi ſua ſoluta anaticè homogenea deſerat, digeſtus in nobis; illorum tamen aliquot vires mutuatus eſt, quas intra defert, plurimorun morborum domitrices:* 'But if 'you come not to that arcanum of *Pyrotechny*, 'learn at leaſt to make the ſalt of tartar volatile, 'that by means of it you may perfect your ſo-'lutions. Which though it leave thoſe things, 'which it diſſolveth, equally homogeneous, be-'ing digeſted in us; yet it borroweth ſome of 'their virtues, which it carrieth along with it 'ſelf

Of the power of chymiſtry.

Of the power of noble menſtruums particularly.

Helm. De Febr. cap. 5. num. 26.

Helmont. de ſign. c. 17. verſ. finem.

'ſelf to overcome diſeaſes.' For concerning this ſalt, he not only elſewhere ſays, *Dicam ſaltem pro ingenuis, quod ſpiritus ſalis tartari, ſi unicornu, argentum, hydrargyrum, lapides cancrorun, vel aliquod è ſimplicibus diſſolverit, nedum febrim, ſed & plures affatim morbos ſanet, &c.* 'I will ſpeak it for their ſakes, who 'are ingenious, that the ſpirit of ſalt of tartar, 'if it diſſolveth unicorn's horn, ſilver, quick-'ſilver, crabs eyes, or other like ſimples, it 'will cure not only fevers, but other diſeaſes 'in great abundance.' But in another place he gives us, together with ſome account of its way of working, this great and comprehenſive commendation of it: *Mirum ſanè*, ſays he, *quantum ſal tartari, vel unicum, volatile factum, non præſtiterit: nam omnem è venis amurcam detergit & obſtruentium contumaciam, diſpergitque apoſtematum ſuſcepta conciliabula. De hoc ſalis (& non olei) ſpiritu, verum eſt illud Paracelſi, quod quocunque non attigerit, vix alius potentior perveniet*: 'It is a wonder what 'the very ſalt of tartar alone being made vola-'tile will perform; for it cleanſes the veins of 'all the feculencies and the cauſes of contu-'macious obſtructions, and doth diſperſe the 'congregated matter of apoſtems. Of this 'ſpirit of the ſalt (and not of the oil) is that 'ſaying of *Paracelſus* true, that whither this 'medicine cannot reach, there is ſcarce any o-'ther more powerful, that ſhall reach it.' Theſe paſſages I ſhould not think worth tranſcribing and laying together, but I find, that beſides the concurrent teſtimonies of *Helmont*, *Paracelſus*, and *Baſilius* in praiſe of this ſalt, the generality of the more inquiſitive chymiſts, without excepting the more ſober and judicious, do, by the various and painful, though fruitleſs attempts they have made to volatilize ſalt of tartar, conſpire in acknowledging it a thing highly worth labouring for; nor do I for my part ſee (whatever ſome ſay to the contrary, and however I have indeed found it more difficult, than perhaps a novice in chymiſtry would think) it ſhould be impoſſible; for I have more than once, with eaſe enough, made gold it ſelf volatile, though it be confeſſed to be the fixedeſt body in the world, and conſequently more fixed than ſalt of tartar, which in an open veſſel may be in time made to fly away by a vehement fire. And I have likewiſe, by an unuſual method, that I have elſewhere delivered, more than once obtained from a mixture of crude tartar, and two or three mineral bodies, good ſtore of true volatile ſalt, which I could ſee no juſt cauſe not to think afforded by the tartar. But I muſt confeſs this may be rather a volatile ſalt of tartar, than ſalt (that is alkali) of tartar made volatile; and therefore the principal thing I mention it for, is to ſhew you, that tartar it ſelf, by an unuſual way of management, may be brought to afford an unuſual kind of ſalt. But this I can tell you, that an ingenious acquaintance of mine, whom notwithſtanding my wonted diſtruſts of chymiſts, I durſt credit, affirmed to me, that he had himſelf ſeen a true and real *Sal tartari volatile*, made of alkali of tartar, and had ſeen ſtrange things done with it, inſomuch that he believed moſt of the things, that *Helmont* delivers of it. For my part I am inclined to think, that ſalt of tartar may be made volatile, (whether in the form of a ſublimate or a liquor) by more ways than one, though not all of them near equally good. And whereas one of the beſt (if not the very beſt) of the ways of volatilizing it, ſeems to do it principally with ſpirit of wine, and the great difficulty of that way conſiſts in bringing this ſpirit to aſſociate with the ſalt; I have ſeen ſalt of tartar of my own brought to that paſs, which great Virtuoſi have long in vain attempted to bring it unto, namely, to flow readily upon a red-hot iron, and alſo to take fire, and burn with a conſpicuous flame, beſides that when it had been dried by a ſmart fire, to drive away any parts, that did not firmly adhere to it, it would yet readily diſſolve in high rectified ſpirit of wine, which you know ſalt of tartar will not otherwiſe do; not to mention the change of its alkalizate taſte, and other leſſer alterations: but what I can farther ſay of this matter, I muſt not declare in this place.

Helm. de ſcholar. humoriſm. paſſ. decept. c. 2. num. 89.

The power of ſal tartari volatilized.

Of the poſſibility of volat. lizing it.

AND, *Pyrophilus*, that you may not be, as many other Virtuoſi, diſcouraged from labouring for noble menſtruums, by the confident perſuaſion of many, who believe *Angelus Sala* and *Guntherus Billychius*, (whom I deny not to have been learned men, do not take to have been great maſters of chymical *Arcana*) fit to determine with authority what can, and what cannot be done by chymiſtry; leſt, I ſay, you ſhould be, by ſuch men's inconſiderate ſeverity, brought to deſpair of ever ſeeing any noble menſtruum, that is not ſharp to the taſte, nor of any of the three peculiar kinds of ſaline liquor; (acid, as aqua fortis; urinous, as the ſpirits of blood, urine, and other animal ſubſtances; nor alcalizate, as oil of tartar *per deliquium*:) I ſhall aſſure you, that to my own knowledge there is in the world a kind of menſtruum, that conſiſts of a pure cryſtalline ſubſtance, that is made by the fire, and as truly ſaline as ſalt of tartar it ſelf; which ſtrange ſalt, though well purified, and readily diſſoluble, as well in dephlegmed ſpirits of wine, as common water, and though it be totally volatile (whence you may gueſs of how ſaline a nature it is) and alſo be either way reducible to a noble menſtruum, does really taſte ſweet; I mean not in the chymical ſenſe, by want of ſourneſs, (as when they ſay, that the *calces* of corroded and precipitated things are dulcified by frequent ablutions) but by a poſitive ſweetneſs. And whereas the vulgar ſaline menſtruums, (which alone ſeem to have been known to *Sala* and *Billychius*) are ſo ſpecificated, if I may ſo expreſs it, that what an acid menſtruum diſſolves, an alcalizate or an urinous will precipitate, *& è converſo*; and whichſoever you chooſe of theſe three ſorts of menſtruums, one of the other two will diſarm and deſtroy it; I have found by trial, not only that a red tincture of glaſs of antimony, being drawn with a menſtruum, that was but a degree to this liquor, I could not precipitate it like our common tinctures, either with ſpirit of urine, or an alcalizate ſolution. But that (which is far more conſiderable) though it would readily mix with acid

That there may be other menſtruums beſides ſuch as are acid, urinous, or alkalizate.

How theſe ſeveral diſarm and deſtroy one another, and what an acid menſtruum diſſolves, an urinous or alkalizate doth precipitate.

Of a menstruum like to all these.

spirits, as oil of vitriol, with volatile and urinous spirits, as spirits of urine it self, and with alcalizate solutions; yet would neither of these three make any ebullition at all with it, or seem to work at all upon it. But of such matters, no more at present.

CHAP. IX.

That chymistry it self (much more physiology) is capable of affording a new and better methodus medendi.

YOU will perhaps expect, *Pyrophilus*, that treating of the advantages, that may accrue to the therapeutical part of physick, from a more accurate knowledge of natural philosophy, I should tell you with the chymist, that chymistry it self, and much more physiology in its full extent, is not only capable of improving the pharmaceutical part or preparations for remedies, (for that we confessed already;) but also of affording us a new and much better *methodus medendi*, or skill of using the helps, that nature or art hath provided against diseases. And indeed the physician's art is so difficult, and a man must know so many things, to be, though not tolerably, yet perfectly skilled in it, that it may, without disparagement to physicians, be thought yet capable of being improved, if not of being reformed. *Hippocrates* begins his aphorisms with a complaint, that life is short, but art long. And *Paracelsus* himself, though he say after his boasting manner, *Ars est longa, vita brevis, ubi autem donum finis* (as he speaks) *est, ibi ars est brevis, vita verum longa, si arti conferatur:* 'Art is long, life is short. But where 'the end is by gift, there art is short, and 'man's life long, if it be compared to art.' Yet expounding the same words a little above, he saith, *Itaque Hippocrates meritò de eo conqueritur: nam & affectis ipsius idem accidit: ars medica consistit in philosophia, astronomia, alchymia, & physica; meritò igitur dici potest artem esse longam. Multum enim requiritur temporis, ad quatuor has columnas medicinæ discendas & perscrutandas.* 'Therefore *Hippocrates* had 'reason to make the complaint, for it even 'happened to his followers according to his 'words. The art of medicine consists in 'philosophy, astronomy, chymistry, and phy-'sicks; and therefore it may truly be said, that 'the art is long: for there is much time re-'quired, thoroughly to learn and search these 'four pillars of medicine.' *Celsus*, who hath been styled *Hippocrates Latinorum*, doth more than once call physick a conjectural art, as particularly in that place, where he saith, *Est enim hæc ars conjecturalis, neque respondet ei plerumque non solum conjectura, sed etiam experientia:* 'For this art is conjectural, and not 'only conjecture, but experience it self doth 'not always answer.' And well might these great men acknowledge their art to be difficult, since the two instruments (as *Galen* calls them) of finding arts, being judgment and experience, *Hippocrates* gives this character of them; ἡ δὲ πεῖρα σφαλερὴ, ἡ δὲ κρίσις χαλεπὴ· 'Expe-'perience is uncertain and fallacious, judg-'ment is difficult to be made.' And that experience may be uncertain without the theory of physick, he, that so much builds upon experiments, *Paracelsus* himself, seems to confess; where expounding the words of *Hippocrates*, he saith, *Hoc modo se habuit medicina in principio; ut nullam theoriam habuerit, sed solùm experientiam hoc laxare, hoc constipare, quomodo autem & cur, id ignoratum fuit: ideo unus salvatus est, alter perditus, nunc autem, &c.*' 'And 'this was the fashion of medicine in the begin-'ning, that it had no theory, only experience, 'that such a thing was laxative, such a thing 'astringent: but how, or why they were so, 'that was not found out; and therefore one 'was healed, another perish'd: but now, &c.' And concerning the critical part of physick (to allude to *Hippocrates*'s expression) *Galen*, who exercised his reason so much about it, tells us that, *per rationem judicium haudquaquam facile exsistit, sed, si quid aliud, maximam habet difficultatem:* 'By reason it is not easy in a disease 'to give judgment, but it is as difficult as any 'thing imaginable.' And to affirm the difficulty of finding the best way of imploying reason to the cure of diseases, not only by the authority of *Galen*, but his arguments; let me inform you, that after having told us, how difficult a thing, and how rarely to be found is that reason, which considers, and determines what on every occasion is to be done, *Neque enim* (adds he) *si veritas esset inventu facilis, tot ac tanti viri in ea quærenda occupati, in tam contrarias sectas fuissent unquam dispertiti:* 'For 'if the truth were easy to be found, so many 'and so excellent men, as have made it their 'business to find it, had never been divided 'into so many sects and opinions.' And *Paracelsus*, whatever he often elsewhere boastingly affirmeth of himself, yet handsomely enough both expresseth and confesseth the difficulty of being a good physician, in one of his *Prefaces* to the Students of Physick; where he says, *Non titulus, non eloquentia, non linguarum peritia, nec multorum librorum lectio (etsi hæc non parum exornant) in medico consideranda, sed summa rerum ac mysteriorum cognitio, quæ una facile aliorum omnium vices agit. Rhetoris quidem est disertè posse loqui ac persuadere, atque judicem in suam sententiam trahere. Medici autem effectuum genera, causas ac συμπτώματα novisse, & iis insuper sagacitate ac industriâ pharmaca applicare, atque pro cujuslibet ingenio ac ratione vel cunctis mederi:* 'It 'is not a title, nor eloquence, nor skill in 'the tongues, nor the reading of many books '(though these are ornaments) which are to be 'considered in a physician; but a prime know-'ledge of matters and mysteries, which alone 'may stand in the stead of all the rest. It is 'the part of a rhetorician to speak eloquently, 'to be able to persuade, and to draw the judge 'to his own party. It is the part of a phy-'sician to know the several sorts of diseases, 'their causes and symptoms, and then with 'skill and industry to apply medicines and 'to make cures of them all, according to their 'several natures and fashions.' But though, *Pyrophilus*, after the acknowledgments made by such great men of the almost insuperable difficulty of their art, you would perhaps think it no great presumption, if a man should attempt to innovate in any part of it, and consequently

Lib. 2. c. 6.

In præfat. lib. 1.

In Commentar. Aphoris. 2.

Paracelsus *in his* Preface to *his* Bertheona, *or* Chirurgia minor.

ſequently even in the *methodus medendi*: yet, *Pyrophilus*, I am much too young, too unlearned, and too unexperienced, to dare to be dogmatical in a matter of ſo great moment. And the phyſicians are a ſort of men, to whoſe learned writings on almoſt all ſubjects, the commonwealth of learning is ſo much beholden, that I would not willingly diſſent from them, about thoſe notions in their own profeſſion, wherein they ſeem generally to agree; and do very much diſapprove the indiſcreet practice of our common Chymiſts and Helmontians, that bitterly and indiſcriminately rail at the methodiſts, inſtead of candidly acquieſcing in thoſe manifeſt truths, their obſervations have enriched us with, and civilly and modeſtly ſhewing them their errors, where they have been miſtaken. And yet, *Pyrophilus*, ſince divers of the eminenteſt methodiſts themſelves have more than once ingeniouſly acknowledged to me, and ſeriouſly deplored with me, in the compleatneſs of their art, (which perhaps made that learned prince, the late king, tell them, that they were at beſt but good gueſſers;) and ſince about divers particular diſeaſes we have obſerved, the method of ſome of the moſt reputed doctors of *England* (which yet, I think, is as well ſtored with learned men of that profeſſion, as any part of *Europe*) not only differing, but repugnant to each other; I ſuppoſe we may, without diſreſpect to their profeſſion, diſſent from the moſt of them about thoſe caſes, about which they are reduced to diſagree ſo much among themſelves. And it would be worth an impartial diſquiſition, whether, ſince the *methodus medendi* ought to be grounded on, and accommodated to, the doctrine of diſeaſes, the new anatomical diſcoveries formerly mentioned, and others not yet publiſhed, do not, by innovating divers things in pathology, require ſome alterations and amendments in the *methodus medendi?* But in this particular, I dare yet affirm nothing; and therefore ſhall proceed to obſerve to you, that the unuſual efficacies of new remedies may probably make the method of curing more compendious, becauſe (as I lately alſo intimated) one medicine may be ſo richly qualified, as to anſwer ſeveral intentions, which, in the common way, require diverſity of helps and remedies. Thus, for inſtance, in the cure of the king's-evil; by the received method, the phyſician muſt propoſe to himſelf ſeveral ſcopes (ſuited to ſeveral indications) and proſecute them ſucceſſively with diſtinct and appropriated remedies. But I have (as I formerly alſo told you to another purpoſe) known a ſingle ſpecifick ſimple, (namely, *Paronychia folio rutaceo*) given only in ſmall beer, in not very many days, without any ſenſible evacuation, waſte the peccant humour, appeaſe the pains (which before were very great) and diſcuſs the unbroken tumours, and heal the broken ones. Thus, according to the known method, the great remedy in pleuriſies is copious blood-letting, which is ſtrictly preſcribed, even to aged perſons and teeming women, by the famouſeſt of our practitioners; and, I confeſs, not irrationally where the phyſician is furniſh'd but with vulgar remedies: and yet by ſome Helmontian medicines, we have known pleuriſies cured even in young men, without phlebotomy, and our ſelves, ſome while ſince, made a ſucceſsful trial of that nature in a young gentleman not unknown to you: which I mention not, with *Helmont*, to reject, or ſo much as to diſparage phlebotomy in this diſeaſe, (for ſo it be moderate and ſeaſonable, experience ſhews it frequently proves uſeful) nor, as if we had obſerved all *Helmont*'s boaſted remedies (though for the moſt part good ones) to be conſtantly ſucceſsful; but to give you an inſtance of the truth of what I was ſaying before, that new and more generous remedies may ſo far alter the received *methodus medendi*, as to make divers of its preſcriptions unneceſſary. Of this truth, *Pyrophilus*, another inſtance might be afforded by the rickets, a new and abſtruſe diſeaſe, at leaſt as is ſuppoſed; and ſometimes ſo ſtubborn, that one of the famouſeſt phyſicians in *Europe*, (whom I think I need not name) hath not been able of late to cure it in ſeveral of his own children. And yet, I ſuppoſe, you may have heard that excellent perſon, your mother, ſeveral times mention her having performed divers cures (ſome of them improbable enough) of this diſeaſe, barely by that ſlight preparation of colcothar, lately taught you, and preſented her by us; and by which (we having made and diſtributed, at her deſire, a conſiderable quantity of it) ſeveral other perſons have freed children from that diſfiguring ſickneſs: of which, but few months ſince, your little couſin *D.* being almoſt paſt hope, was a while ſince brought out of danger, by God's bleſſing upon ſome of the ſame remedy, wherewith we preſented her mother, together with our perſuaſions to try it in her own child, as ſhe had ſucceſsfully done on the children of divers others. And yet this remedy (to add that upon the by, in favour of ſomething to be ſaid anon) works almoſt inſenſibly, ſave that in many bodies it is, eſpecially at firſt, diaphoretick. And this property of that remedy minds me to add, that it would not be amiſs for phyſicians, to conſider, whether or no (however, bleeding, purging, vomiting, iſſues, glyſters, ſcarifications, and thoſe other painful ways of evacuation, be not, however chymiſts are too bitterly and undeſervedly wont to reject them, to be altogether condemned and laid aſide, yet) there may not in ſome particular diſeaſes and bodies be found more gentle, and yet effectual ways of diſcharging nature of that which offends her, than thoſe painful and debilitating ones, which we have mentioned, (without the uſe of one of the chief of which, namely, phlebotomy, we ſee that almoſt all kinds of diſeaſes are cured in children.) The contributing to render the ways of cure leſs painful and weakening, would gratify ſo great a part of thoſe, who may need phyſick, that I hope, you will eaſily pardon my ſpending ſome pages to that purpoſe. I conſider then, that oftentimes the peccant matter, though very offenſive by its qualities, is much leſſer than is ſuppoſed, in quantity, and might, if we were but maſters of ſpecifick remedies, either be breathed out by inſenſible tranſpiration,

Inſtances to prove, that the unuſual efficacies of new remedies may alter and make the method of curing more compendious; in the king's evil.

Pleuriſies.

In the rickets.

tranſpiration, or carried off by ſweat or urine, without tormenting or weakening the patient, by thoſe other copious evacuations of groſſer matter, which are always troubleſome and painful enough, though not always eſſential. Nay, that even in chirurgery it ſelf, if thoſe, that practiſe it, were as knowing as nature has been bountiful, there would not be ſo often a neceſſity, as it is commonly ſuppoſed there is, of mutilating or tormenting the patient to recover him, you cannot doubt, unleſs you will deny what *Gulielmus Piſo* affirms, upon his own obſervation, of the cures done by the illiterate Indian empiricks. The paſſage you have ſeen already; but to it he adds ſo notable and ingenious an acknowledgment, that I cannot but honour him for it, and be willing to make way for the credibility of a good part of what we are hereafter to deliver, in this diſcourſe, by premiſing it: *Immo* (continues he) *ex venenatorum fungorum aliorumque toxicorum eſu, ſolo potu infuſi recentis radicis Jaborandi in inſtanti à letho vindicatos, me aliiſque Galeni nepotibus haud parum pudore ſuffuſis, poſt tot alexipharmacorum & theriacalium antidotalium irritos conatus. Ita ut poſtea ejuſmodi collegas barbaros ſubinde mihi adjungi paſſus ſim, non adeo quidem noſtratium valetudinem ad tactum arteriarum moderari, quam dictis modis conſiliis copiam præbere ſolitos.* 'Nay, I ſaw divers, as it were in an 'inſtant, redeemed from death, who had 'been poiſoned by the eating of venomous 'muſhrooms and other unwholeſome things, 'only by drinking a recent infuſion of the root 'Jaborand, whilſt my ſelf and other of *Galen*'s 'diſciples bluſh'd to ſee the ineffectual endeavours of all our alexipharmaca, treacles, and 'other antidotes: ſo that afterwards I ſuffered 'my ſelf to be joined in conſultation with thoſe 'barbarous collegues, not ſo much to be arbiters of the condition of our men by their 'pulſe, as to give their aſſiſtance and counſel 'in the forementioned way, *viz.* the preſcribing of proper medicines.' Thus far he: which premiſed, let us proceed to conſider, more particularly, ſome of the leſs painful ways of freeing men from diſeaſes.

CHAP. X.

That great cures may be done by outward applications.

THAT great cures may be done by bare outward applications, you will ſcarce deny, if you diſbelieve not the relations, which are made us, by learned men, concerning the efficacy of the *lapis nephriticus* only, bound upon the pulſes of the wriſts (chiefly that of the left hand) againſt that ſtubborn and anomalous diſeaſe the ſtone: and that, which gives the more credit to theſe relations, is, that not only the judicious * *Anſelmus Boëtius de Boot* ſeems to prize it, but the famous *Monardes* profeſſeth himſelf not to write by hearſay of the great virtues of this Indian ſtone, but to have made trial of it himſelf upon perſons of very high quality. And that which is related by † *Monardes* is much leſs ſtrange, than thoſe almoſt incredible things, which are with many circumſtances delivered of that ſtone, by the learned chymiſt ‖ *Untzerus*. And although it muſt be acknowledged, that ſome ſtones that go under the name, have been ineffectually applied in nephritick diſtempers, yet the accurate *Johannes de Laet* himſelf furniſheth us with an anſwer to that objection, informing us, that many of thoſe nephritick ſtones (which differ much in colour, though the beſt are wont to be greeniſh) although not at all counterfeited, or ſophiſticated, are of little or no virtue. But that yet there are ſome others of them, which can ſcarce be diſtinguiſhed from the former, but by trial upon nephritick perſons, which are of wonderful efficacy; as he himſelf hath more than once tried in his own wife. *Garcias ab Orto* (Lib. 1. cap. 53.) mentions a ſtone, found in *Balagat* called *Alaqueca*; of which he tells us, that though it be cheap, *Hujus tamen virtus* (to uſe his own words) *reliquarum gemmarum facultates exuperat, quippe qui ſanguinem undiquaque fluentem illico ſiſtat.* 'The virtue of this ſtone is much above that 'of any other gems; for it ſtops the flux of 'the blood in any part.' *Monardes* (cap. 35.) relates the great virtues of a ſtone againſt hyſterical ſuffocations, and concludes, *Cum uteri ſuffocationem imminentem præſentiunt, adhibito lapide ſubito levantur, & ſi eum perpetuo geſtant (hyſterici) nunquam ſimili morbo corripiuntuur, exempla hujuſmodi faciunt, ut his rebus fidem adhibeam.* 'When the women perceive a fit 'of the mother coming upon them, by apply-'ing this ſtone they are immediately eaſed; 'and if they always wear it, they are never 'troubled with thoſe fits more. Of this they 'make faith, by many inſtances.' The ſame author, in the next chapter, treating of the *lapis ſanguinaris*, or blood-ſtone, found in new *Spain*, (having told us, that the Indians do moſt confidently believe, that if the fleſh of any bleeding part be touched with this ſtone, the bleeding will thereby be ſtanched) adds this memorable obſervation of his own; *Vidimus nonnullos hæmorrhoidum fluxu affictos remedium ſenſiſſe, annulos ex hoc lapide confectos in digito continue geſtando; nec non & menſtruum fluxum ſiſti.* 'We have ſeen ſome, that were 'troubled with the flux of the hæmorrhoids, 'who found remedy by wearing rings made of 'that ſtone continually on their fingers, and 'the monthly flux is ſtaid by the ſame way.' And of the formerly mentioned *lapis porcinus*, the experienced *Bontius* (having mentioned how the Indians give the wine, wherein it hath been ſteeped, againſt the diſeaſe called *Cholera*; which is as much, and as juſtly feared, by the iſlanders of *Java*, as the plague is in *Holland*) adds this memorable paſſage: *Prægnantibus tamen hic lapis non bene datur; nam abortum provocare adeo certum eſt, fœminæ Malaicæ mihi retulerint, ut ſi quando menſtrua eorum purgatio non bene procedat, ſi ſaltem hunc lapidem manu geſtent, juvamentum ſe inde ſentire.* 'This ſtone 'is not proper for thoſe, who are with child, for 'it is ſo ſure to cauſe abortion, that the women 'of

Franciſcus Bernius, Donzellinus, Erneſtus Burgravius; *who commend it upon their own experience, beſides very many, that commend it in general terms.*

* *De Lapid. & Gem.* Lib. 2. cap. 11. † *Nicolaus Monardes de ſimplic. Ind. Hiſt. à. ſeu tit.* 20. ‖ *De Nephrit.* Lib. 1. c. 24. where he hath nine or ten *Obſervationes raræ & inauditæ de Lap. Nephritico.* Of the efficacy of *Lapis Nephriticus* and other *appenſa. De Gem. & Lapidibus*, Lib. 1. c. 23.

'of *Malaica* told me, that if at any time their 'monthly evacuations were obſtructed, that if 'they only carried this ſtone in their hands, they 'found remedy thereby.' And the relations, *Pyrophilus*, that I may in another place preſent you with, concerning the wonderful ſtone, formerly mentioned, with which your grandfather performed ſuch eminent cures, (particularly of the ſtone, in the Lord of *Falkland*, then deputy of *Ireland*, and others, to whoſe backs it was applied) will, I ſuppoſe, make you the more readily give credit to the relations of the authors we have newly mentioned.

Helm. de lyth. c. 2. What *Monardes* mentions of the virtue of the *lapis ſanguinaris*, to cure hæmorrhoidal fluxes, puts me in mind of a yet much ſtranger thing, which *Helmont* affirms; namely, that he could make a metal, of which if a ring were worn, the pain of the hæmorrhoids would be taken away, in the little time requiſite to recite the Lord's prayer; and within twenty four hours the hæmorrhoids themſelves, as well internal as external, how protuberant ſoever, would vaniſh, and the reſtagnant blood would (as he ſpeaks) be received again into favour, and be reſtored to a good condition. The ſame ring he alſo commends in the ſuffocation and irregular motion of the womb, and divers other diſeaſes: but if *Paracelſus* be in any caſe to be credited in an unlikely matter, we may think, by his very ſolemn proteſtations, that he ſpeaks upon his own experience, that he had a ring made of a metalline ſubſtance, by him called *electrum*, (which, by his deſcription, ſeems to be a mixture of all the metals joined together under certain conſtellations) which was of a far greater virtue than this of *Helmont*; for, *Hoc loco* (ſays he) *non poſſum non indicare admirandas quaſdam vires virtuteſque electri noſtri, quas fieri his noſtris oculis videmus, adeoque cum bona veritatis conſcientia proferre atteſtarique poſſumus. Vidimus enim hujus generis annulos, quos qui induit, hunc nec ſpaſmus convulſit, nec paralyſis corripuit, nec dolor ullus torſit, ſimiliter nec apoplexia, nec epilepſia invaſit. Et ſi annulus hujuſmodi epileptici digito annulari, etiam in paroxyſmo ſæviſſimo, incertus fuit, remittente illico paroxyſmo, æger à lapſu illico reſurrexit, &c.*

Paracelſ. in Archidox. Magic. lib.

'In this place I cannot but relate the admirable virtues of our electrum, which I have obſerved with my own eyes, and therefore can atteſt with a good conſcience. For we ſaw rings of it, which he that wore neither felt cramp, nor palſy, nor other pain. He was ſubject to no fits of apoplexy, nor epilepſy, inſomuch that if one of theſe rings were put upon the ring-finger of a perſon actually in any vehement fit of the falling ſickneſs, that fit would immediately aſſuage, and the perſon as ſoon come to himſelf.' But to take notice of ſome other outward remedies. To our preſent theme belongs that noble cure, performed by the famous and experienced *Fabricius ab Aquapendente*; who tells us, that he cured a man of a *ſcirrhus lienis*, and a dropſy, by the long uſe of ſponges, moiſtened with common lime-water, and then expreſſed and worn upon the ſpleen; notwithſtanding the muſcles of the abdomen, and all the other parts, that lie betwixt the applied ſponge and the part affected. And to this we may add the ſtrange cures mentioned by *Kircherus*, and confirmed to me by a learned eye-witneſs, to be frequently performed, of very dangerous diſeaſes, in that cave near *Rome*, where the patient being expoſed ſtark naked, and tied hand and foot upon beds of ſtraw; and being by the ſulphureous vapour of the place, and ſometimes their own fear, caſt into a ſweat, are licked well by a great number of peculiar kind of ſerpents that inhabit that grotta. Moreover, we oftentimes ſee agues cured by amulets and applications to the wriſts, and I myſelf was, about two years ſince, ſtrangely cured of a violent quotidian, which all the wonted method of phyſick had not ſo much abated, by applying to my wriſts a mixture of two handfuls of bay-ſalt, two handfuls of the freſheſt Engliſh hops, and a quarter of a pound of blue currants, very diligently beaten into a brittle maſs, without the addition of any thing moiſt, and ſo ſpread upon linen cloth, and tied about the wriſts. And with the ſame remedies (which yet we have obſerved ſometimes to fail) have divers others been cured, both of quotidian and tertian agues: nay, an eminent phyſician gave me, lately, thanks, for the great effects he had found of it, even in continual fevers.

Of ſtrange cures performed near Rome *in the ſerpentine grotta.*

De operat. chirurg. p. 1. c. 15.

The cures of the dropſy and ſcirrhus lienis by the external application of ſponges dipt in lime-water.

Of the operations of ſulphur, cantharides, quick-ſilver, and tobacco externally applied.

AND here, *Pyrophilus*, I ſhall not ſcruple to acquaint you with my having ſometimes wiſhed, that phyſicians had been a little more curious to make obſervations and trials of the diſtinct operations of various bodies outwardly applied. For I conſider, that, in ſome of them, the ſubtile corpuſcles, (which ſeem to inſinuate themſelves into the pores of the body, and into the maſs of blood, with little or no alteration) have much the like operations with the body, whence they exhale, taken in at the mouth. As we ſee in ſome preparations of ſulphur, which have like vertues, inwardly given, and outwardly applied; and more manifeſtly in *Cantharides*, which I have found, by external application, to work ſtrangely upon the bladder, as that they excoriated it when taken into the body; and yet more manifeſtly in quick-ſilver, which by inunction may be made as well to ſalivate, as if it were ſwallowed down. And an eminent phyſician lately complained to me, that waſhing a child's ſcabby head with a decoction of tobacco, to kill and dry up the ſcabs, the boy was made thereby both ſick and drunk. And learned men aſſure us, that by ſome catharticks outwardly applied, thoſe may be purged, that will not ſwallow phyſick. But other medicines there are, which, before they get into the maſs of blood, are much altered, either in ſtraining through the fleſh and membranes of the body, or in the digeſtions they paſs through in the ſtomach, and elſewhere. And theſe may have very differing effects, inwardly given, and outwardly applied; as in the formerly mentioned inſtance of hops, currants, and ſalt, neither any of the ingredients inwardly given, nor the mixture hath been (that I know of) noted for any febrifugal virtues. So likewiſe turpentine and ſoot, that inwardly taken are good for quite

Inſtances in divers medicines, which have differing effects inwardly given, and outwardly applied.

other diſeaſes, (as pleuriſies, and obſtructions of the kidneys) outwardly applied are the main ingredients of pericardiums, extolled againſt agues. And millefolium or yarrow, beſides the virtues it hath inwardly againſt diſeaſes of quite other natures, being worn in a little bag upon the tip of the ſtomach, was (as himſelf confeſt to me) the ſecret againſt agues, of a great lord, who was very curious of receipts, and would ſometimes purchaſe them at very high rates. And a very famous phyſician of my acquaintance did ſince inform me, that he had uſed it with ſtrange ſucceſs. I know alſo a very happy phyſician, who aſſures me, that he hath very often cured, both in himſelf and others, the chilblains, when they come to be broken, by barely ſtrowing on the ſore parts the fine powder of quinces thinly ſliced and dried. And who knows, what unexpected operations divers other bodies may have, when outwardly applied, if various trials of that nature were ſkilfully made; eſpecially ſince we ſee, that (for reaſons elſewhere to be conſidered) ſome bodies ſeem to have quite contrary operations, when outwardly applied and inwardly taken? For we ſee, that ſpirit of wine does, in ſeveral caſes, allay the inflammation of the external parts, which given inwardly would quickly inflame the body. And our often commended *Piſo*, ſpeaking of a choice remedy for thoſe diſtempers of the eyes, that uſed to trouble men in *Braſil*, adds, *Idem quoque præſtat maniphera, ex radice mandihoca, quæ licet pota venenoſa habeatur* (as we formerly noted out of his and other teſtimonies) *oculis tamen prodeſt, viſumque emendat.* And if the ſimples, to be outwardly applied, be ſkilfully prepared, that may much vary and improve their operations. As we ſee, that vitriol, which is made of copper, or iron corroded by, and coagulated with acid ſalts, hath outwardly divers virtues, which crude copper has not either outwardly or inwardly. And gold diſſolved in aqua regis, and precipitated with oil of tartar, is inwardly, as far as I can diſcover, gently purgative; yet the ſame *aurum fulminans* being calcined with twice or thrice its weight of flowers of brimſtone, till the *flores* be burnt away, is known to be much commended by chymiſts, and others, for a diaphoretick. But though, as to any outward virtues of the ſame powder, phyſicians and chymiſts are wont to be ſilent, yet probably it may have very great ones, as well as quite differing from thoſe it has, being taken at the mouth. For I know a perſon, that being grievouſly tormented with exulcerated hæmorrhoids, a very expert chymiſt of my acquaintance, not knowing what elſe to do, applied to the part affected an ointment conſiſting only of *aurum fulminans*, prepared and fixed by a ſlight and familiar way (which you may command) and made up with a little oil of ſweet almonds into a requiſite conſiſtence; and though preſently, upon the application of the remedy, the pain for a quarter of an hour hugely increaſed, yet ſoon after it abated, and the hæmorrhoids the next day were cloſed, and the day after went away; nor has the patient ever ſince (that is, for ſome years) been troubled with any thing of relapſe. And the ſame phyſician aſſures me, that with the like remedy [illegible] found a ſtrange effect in venereal ulcers. And perhaps to this may be referred what has been found by ſome friends of mine, that phlegm of vitriol, and *ſaccharum Saturni*, which not only inwardly given are ſaid much to cool the blood, but outwardly applied are good for burns and hot humours, do yet potently diſcuſs cold tumours. But leſt you ſhould ſay, that this diverſity may proceed (at leaſt in part) from the corpuſcles of differing natures, that may be imagined in the forementioned medicines; I ſhall return to what I was diſcourſing of before, and take notice of the efficacy of ſome other external remedies.

That preparation may much improve ſimples, which are outwardly applied.

Inſtances in divers preparations of gold.

An ointment made of aurum fulminans for the hæmorrhoids and venereal ulcers.

[SINCE the beginning of this eſſay, I ſaw a luſty and very ſprightful boy, child to a famous chymical writer, who, as his father aſſured me and others, being by ſome enemies of this phyſician's, when he was yet an infant, ſo bewitched, that he conſtantly lay in a miſerable torment, and ſtill refuſing the breaſt, was reduced, by pain and want of food, to a deſperate condition, the experienced relater of the ſtory remembering, that *Helmont* attributed to the *electrum minerale immaturum Paracelſi* the virtue of relieving thoſe, whoſe diſtempers come from witchcraft, did, according to *Helmont*'s preſcription, hang a piece of this noble mineral about the infant's neck, ſo that it might touch the tip of the ſtomach; whereupon preſently the child, that could not reſt in I know not how many days and nights before, fell for a while aſleep, and waking well, cryed for the teat, which he greedily ſuckt, from thenceforth haſtily recovering, to the great wonder, both of his parents, and ſeveral others, that were aſtoniſhed at ſo great and quick a change. And though I am not forward, to impute all thoſe diſeaſes to witchcraft, which even learned men father upon it; yet it is conſiderable in our preſent caſe, that whatſoever were the cauſe of the diſeaſe, the diſtemper was very great and almoſt hopeleſs, and the cure ſuddenly performed by an outward application, and that of a mineral; in which compacted ſort of bodies, the finer parts are thought to be more locked up.]

The cure of a perſon eſteemed bewitched, by an appended mineral.

AMONG the proofs of the efficacy of appended remedies, we muſt not pretermit the memorable examples, that are delivered by the judicious *Boetius de Boot*, concerning the virtues of that ſort of jaſper, which is blood-red throughout the whole body of the ſtone, not being mingled with any colour: *Teſtari poſſum* (ſays he) *me, qui alias lapidibus & gemmis tantas vires, quantas vulgus ſolet, non tribuo, credibile vix, de jaſpidis viribus, obſervaſſe. Nam cum ancilla fluxu menſtruorum ita laborâſſet per aliquos dies, ut nullo modo ſiſti poſſet, jaſpidem rubram impolitam & rudem femori alligari juſſi. Alius (in eadem domo) cum in pede vulneratus eſſet, nec ſanguinis fluxus cohiberi poſſet, admoto lapide, extemplo impeditus fuit, licet vulnus non tegeretur.* To theſe he adjoins a much more memorable example, of a maid he cured at *Prague*, who had been for ſix years ſick of an hæmorrhagy ſo vehement, that there ſcarce ever paſt a week, in which ſhe did not ſeveral times bleed,

The power of the jaſper to ſtanch blood.

De Lapid. & Gem. l. 2. cap. 102.

bleed, neither could ſhe be relieved by any remedies, though ſhe had long uſed them, till ſhe was quite tired with them: wherefore our author ſetting them aſide, lent her a jaſper, of whoſe virtue in ſuch caſes he had made good trial, to hang about her neck, which when ſhe did, the flux of blood preſently ceaſed, and ſhe afterwards, for curioſity ſake, oftentimes laying aſide the ſtone, and, as often as ſhe needed it, applying it again, obſerved, that whereas the flux of blood did not preſently return upon the abſence of the jaſper, but after divers weeks, yet upon the hanging it on again it would preſently be ſtopt; ſo that ſhe could not aſcribe the relief to any thing but the ſtone, by which our author tells, that at length ſhe was quite cured. And ſpeaking of the praiſes given by others to green jaſper ſpeckled with red, he concludes, *Sed ego, quod multoties expertus ſum, refero.* But amongſt the operations of outwardly appended medicines, I have ſcarce met with a ſtranger than that, which the experienced *Henricus de Heer* mentions in the fourteenth of thoſe obſervations which he truly ſtiles rare, namely, that a woman, who had by an unſkilful midwife the bladder lacerated, and thereby been ſubject to a perpetual *incontinentia urinæ*, and had been reduced conſtantly to wear a ſilver pipe, was perfectly helped, by wearing, as a gipſy had taught her, a little bag hung about her neck, containing the powder made of a live toad, burnt in a new pot. Which relation I the rather mention, not only becauſe the author having tried the remedy upon a merchant, to whom an unſkilful lithotomiſt had left the like diſeaſe, found it preſently to ſucceed; but becauſe having been very deſirous to have further trial made of ſo odd a remedy, by a curious phyſician, he lately gave me this account of it, that though in one or two it had failed, yet having given ſome of the powder to an exquiſite perſon, known to us both, he aſſured him it had ſucceeded in two or three. (And the diſeaſe is too unfrequent, to give occaſion to have the remedy often tried.) And the phyſician adds, that one of thoſe patients tells him (the phyſician) that though her infirmity were occaſioned by a *laceratio veſicæ*, yet the remedy helps her, as long as ſhe wears it about her, in caſe ſhe renew the powder, when the virtue of it begins to decay; but that (which is remarkable to our preſent purpoſe) if ſhe leaves it off a while, ſhe finds the diſeaſe return. The ſame *Henricus ab Heer*, among his freſhly commended obſervations, has another of a little lady, whom he concludes to have been caſt into the ſtrange and terrible diſtemper, which he there particularly records, by witchcraft. Upon ſo ſevere an examination of the ſymptoms made by himſelf, in his own houſe, that if, notwithſtanding his ſolemn profeſſions of veracity he miſ-relate them not, I cannot but wonder he ſhould confidently impute ſo prodigious a diſeaſe to ſome ſupernatural cauſe. But though the obſervation, with its various circumſtances, be very well worth your peruſing; yet that, for which I here take notice of it, is, what he adds about the end of it, concerning his having cured her, after he had in deſpair of her recovery ſent her back to her parents, by an outward medicine, namely, an ointment, which he found extolled againſt pains produced by witchcraft, in a Dutch book of *Carrichter's*: (where alſo I remember I met with it, ſet down a little differing from what he delivers.) Of which wonderful ointment, the ingredient that he found ſo extremely difficult to procure, namely, the miſletoe of hazel, being in *England* not ſo rare, but that I have more than once got it, and found, as he intimates, very green, and (what he mentions not) extremely bitter, I could wiſh, that thoſe, that have the opportunity, would make trial. For beſides what *Carrichter* delivers, and our author relates of it, a learned phyſician did highly commend it to the judicious *Gregorius Horſius*. And though if we allow it to cure bewitched patients, the virtue, that may be in external remedies, will be made ſo much the more conſpicuous; yet ſuppoſing the diſeaſes to be, though ſtrange, yet but natural, we cannot but allow, that there may be a wonderful efficacy in an outward remedy, ſince it was able, only by anointing the joints, and thoſe pained parts with it, to cure a radicated diſeaſe, attended with ſuch wonderful and horrid ſymptoms. And after this it may ſeem but little, what elſe would appear a ſtrange thing, which *Helmont* affirms of a plaiſter he had, wherewith he tells us, that he ſafely cured hundreds of quartans, even autumnal, without relapſe: elſewhere he ſaith, that he made his plaiſter, (for by the circumſtances I preſume he means no other,) of a few reſolving and abſterſive things, and adds, that it never failed him, but only that in fat perſons it ſucceeded more ſlowly. And yet in theſe, and the like ways of curing diſeaſes, though approved, if not alſo commended, by eminent phyſicians both ancient and modern, there is no ſenſible evacuation made of peccant humours, which perhaps materially remain in the body, and may, by the effluvia of theſe remedies, be deprived of their former qualities, and made ſo far obſequious to nature, that ſhe is able, if need be, to eaſe her ſelf of them by ſweat, urine, or undiſcerned tranſpiration.

In Obſerv. Medic. oppido rariſ. p. 194.

The incontinentia urinæ *cured by the powder of a toad burnt alive, and hung about the neck.*

Effects aſcribed to witchcraft, cured per appenſa.

Helmont cured quartans by a plaiſter.

Helmont. De Febr. cap. 14. verſ. finem.

Cap. 17. in fine.

AND that the peccant humours remain for a while materially in the body (the diſeaſe ſometimes being removed) may appear by the cures, which we ſee now and then performed of agues by ſudden frights; by which no diſcernible evacuation is made of humours, though probably ſome conſiderable change be thereby produced in the temper of the maſs of blood, or in the texture of the morbifick matter (as phyſicians call it;) as ſeems probable, both from divers other things mentioned here and there in this eſſay, and particularly from the lately recited paſſage of *Helmont*, where he takes notice of the rectifying of the peccant, and by nature rejected blood, without any ſenſible evacuation, upon the wearing of his ring. I knew a gentleman, a ſtrong and reſolute man, who had been long a ſoldier, and attained the higheſt ſort of military imployments; notwithſtanding which, he was ſtrangely fearful of rats, and could not endure the ſight of them: this gentleman having been long troubled with an obſtinate

Diſeaſes cured by frights.

obſtinate quartan, and travelled with it into ſeveral countries, without being able to find any cure for it, coming at length accidentally and ſuddenly into a place, where a great rat was in a corner, whence he could not fly from the gentleman, he furiouſly leaped upon him (yet without biting him) and thereby putting him into a fright, which freed him from the ague, that long had importuned him. And the experienced *Salmuth* tells us, in a pleaſant obſervation, of one, who was cured even of the gout by a fright. For this man having his feet and hands covered with a poultis, made of turneps, flower and milk, and being left in his chair in a low room, was, whilſt his ſervants were all gone into the garden, aſſaulted by a ſow, who finding the door open, and invited by the ſmell of the cataplaſm, came to devour it; and ſtriving to do ſo, flung the ſick man and the chair to the ground, and put him into ſuch a fright, that our author tells us, that very day his pains decreaſed, and continued leſſening by degrees, till at length they wholly left him, without ever returning to trouble him again. There are divers inſtances, that diſcover what great changes may be produced in the body, without taking in any thing viſibly at the mouth. And on the other ſide, a good air alone doth often, in conſumptions and other diſeaſes, perform what hath in vain been expected from the uſe of emptying phyſick. It were to be wiſhed, that we had, among our European phyſicians, the phyſick books of thoſe of *China*; for though our doctors are much more learned men than theirs, yet probably their writings and their practice may teach us ſomething that is new, and ſomething making for our preſent purpoſe. For the famous Jeſuit *Semedo* informs us, that the books of our phyſicians having not yet been brought to *China*, they are inſtructed in their art by abundance of their own writings; and that though in their practice they do not let blood (as the learned **Varenius* tells us, that neither do the Japonian doctors) or ſet cupping-glaſſes, though they uſe no ſyrups, nor potions, nor any iſſues, but are herbaliſts, uſing nothing but herbs, roots, fruits, ſeeds, &c. yet phyſick (to uſe our author's words) *is in a very good condition in* China, (as *Almeida* alſo tells us, that the phyſicians are much eſteemed in *Japan*;) and of the ſkill of ſome of the Chineſes in that art, he gives us in the ſame chapter ſome conſiderable inſtances. And though, as we ſaid, it is very likely, that their doctors are much inferiour in point of learning to ours; yet it is conſiderable, that in ſo vaſt, ſo civilized, and ſo populous a country, phyſick can be practiſed with reputation, without the uſe of thoſe evacuations, which are here ſo frequently made in phlebotomy, potions and iſſues. Nor ſhould we only expect ſome improvement to the therapeutical part of phyſick, from the writings of ſo ingenious people as the Chineſes; but probably the knowledge of phyſicians might be not inconſiderably increaſed, if men were a little more curious to take notice of the obſervations and experiments ſuggeſted partly by the practice of midwives, barbers, old women, empiricks, and the reſt of that illiterate crew, that preſume to meddle with phyſick among our ſelves; and partly by the Indians and other barbarous nations, without excepting the people of ſuch part of *Europe* it ſelf, where the generality of men are ſo illiterate and poor, as to live without phyſicians. For where phyſick is practiſed by perſons, that never ſtudied the art of it in ſchools, or books, many things are wont to be raſhly done, which, though perhaps prejudicial, or even fatal to thoſe, on whom they are tried, may afford very good hints to a learned and judicious obſerver: beſides, where the practitioners of phyſick are altogether illiterate, there oftentimes ſpecificks may be beſt met with. For ſuch perſons being wont, for want of ſkill in phyſick, and particularly the art of mixing ſimples, and in that of varying their remedies according to circumſtances, do almoſt wholly rely upon ſpecificks; whoſe virtues, from their practice, may be ſometimes better gathered, than from that of ſkilful phyſicians, in regard that thoſe empiricks (beſides that they aſſiſt not with any ſkill in the *methodus medendi* the virtues of their remedies) are wont, for the reaſons newly mentioned, to try obſtinately, and to the uttermoſt, the effects of their few ſpecificks. And the nature of their medicines may be the better known, in regard they are not wont to blend them, as learned men but too often do, with many other ingredients, whoſe mixture, as we formerly noted, either alters their nature, or makes it difficult to determine (as *Galen* himſelf in a like caſe confeſſeth, *Nam, ut verum fateamur, hæc difficilis quoque res eſt & rara inventu, cùm poſt multa remedia adhibita ægrotanti, quod ex iis in cauſa fuiſſe dicitur, ut melius pejuſve habeat*) whether the effect be aſcribed to what is given for the ſpecifick, or to ſome other of the ingredients, or to the whole compound as ſuch. The experienced *Bontius*, in his excellent little tract *de Medicina Indorum*, doth more than once confeſs, that it is very undeſervedly, that the Europeans look upon the Eaſt-Indians as Barbarians. And even of thoſe among them, that are ignorant of other things, he hath this paſſage; *Hinc etiam fit, quod homines cæteris rebus idiotæ tam exactam herbarum & ſtirpium nanciſcantur ſcientiam, ut ſi vel doctiſſimus Pavius, noſtri ævi botanicorum princeps, è mortuis reſurgens huc veniret, miraretur ſe ab hiſce hominibus barbaris doceri poſſe.* And *Linſchoten* in his voyages, ſpeaking of that famous mart of the *Eaſt-Indies*, the city of *Goa*, where the Vice-roy and the Archbiſhop reſided, and he himſelf lived: Theſe heatheniſh phyſicians, ſaith he, mentioning thoſe of *Goa*) do not only cure their own nations and country-men, but even the Portugals alſo; for even the Vice-roy himſelf, the archbiſhop, and all the monks and friars, do put more truſt in them than in their own country-

Obſerv. Cent. 1. Obſerv. 48.

Phyſick now in China *is in a good condition without phlebotomy, potions, or iſſues.* Hiſt. of China, Part. 1. chap. 12.

[*N. B.*]

Where practitioners of phyſick are illiterate, the ſpecificks may be beſt met with.

Galen. aphor. Hipp. comment. 1.

The Uſefulneſs of the knowledge of the medicines of barbarous nations.

Lib. 2. Dialog. 7.

Voyage, c. 34.

* *Medicinæ facienæ mediocrem habent peritiam. Ægris ſalſa, acria, & plura proponunt, dicente Matjeo, piſces & conchylia pharmaca ſuavia & odorata.* [*N. B.*] *Sanguinem nunquam eliciunt. Magnam medicorum dignitatem videre eſt ex Epiſtola Almeidæ, ubi narrat*, &c. Bern. Varenius, in Deſcript. regn. Japon. cap. 25.

countrymen, whereby they get great ſtore of money, and are much honoured and eſteemed. I have not now the leiſure to acquaint you with what I might alledge, to confirm this truth out of the practices of the illiterate natives of ſome not yet ſufficiently civilized part of *Ireland*, and the inhabitants of ſome other places, where phyſicians have not yet ſettled: but I ſhall mind you of the confeſſion of *Celſus*, where ſpeaking of phyſick, *Hæc nuſquam* (ſaith he) *non eſt: ſiquidem etiam imperitiſſimæ gentes herbas aliaque prompta in auxilium vulnerum morborumque noverunt.* And I wiſh, that other learned men would imitate the commendable example, not only of *Proſper Alpinus*, who wrote a treatiſe *de Medicinâ Ægyptiorum*, and of *Jacobus Bontius*, in his *Medicina Indorum*, but of *Gulielmus Piſo*, who hath lately preſented the world with the rude way of curing, uſed by the Braſilians themſelves, in his new and curious books *de Medicina Braſilienſi*, in the beginning of the ſecond of which, he much confirms what we have been delivering, in the enſuing paſſage: *Quemadmodum multa in tam craſſa Barbarie cruda vel corrupta arteque hippocraticâ indigna reperiuntur, ſit etiam nonpauca utiliſſima antiquitatem redolentia, quæ vel eruditiſſimos medicos ad urnas medicinæ ſubjiciunt, obſervanda occurrunt. Quippe cum multarum artium rudimenta vel ab ipſis animantibus brutis (quibus benigna mater natura arte inſita imprimis curandis morbis deſtitui noluit) ad nos redundare fatendum ſit; quis dubitet ab his mortalibus, licet remotiſſimis à dogmaticâ & rationali medendi arte, non plurima nobiliſſima at ſecreta remedia atque antidota, medendi morbos veteribus incognitos quotidiè ad poſteros derivari? quibus paulatim ad manum traditis, & tandem quaſi in ſuccum & ſanguinem à rationalibus converſis doctorum ſcholæ & libri ſuperbiunt?* And to this agrees very well that grave ſaying of our experienced *Harvey*, to the very learned Doctor *Ent: Nulla gens tam barbara eſt, quæ non aut fortuitò, aut inevitabili quadam neceſſitate coacta, aliquid in uſum communem adinvenerit, quod nationes alias humaniores latuit.* Nor ſhould we diſdain the remedies of ſuch illiterate people, only becauſe of their being unacquainted with our theory of phyſick. For though I will not ſay, as the old empiricks wittily enough did in that paſſage of *Celſus*, *Requirere etiam, ratio idem doceat quod experientia, an aliud? Si idem, ſupervacuum eſſe, ſi aliud, etiam contrarium.* But leſt we ſhould by too great reliance on the Galenical, or other ancient opinions, neglect uſeful remedies, becauſe preſented by perſons, that ignore them, and perhaps too hold opinions contrary to them; I ſhall leave you to conſider, what is in the perſon of the ſame empirical ſect, repreſented by *Celſus*, where having ſpoken of the darkneſs of the cauſes of things, and the uncertainty of the theorems of phyſick: *Ac nihil iſtas cogitationes* (ſaith he) *ad medicinam pertinere, eo quoque diſci, quod qui diverſa de his ſenſerint, ad eandem tamen ſanitatem homines perduxerint. Id enim feciſſe, quia non ab obſcuris cauſis neque à naturalibus actionibus, quæ apud eos diverſæ erant; ſed ab experimentis, prout cuique reſpondeant, medendi vias traxerint, ne inter initia quidem ab iſtis quæſtionibus deductam eſſe medicinam, ſed ab experimentis, &c.* For though this ſentence aſcribes too little to reaſon, yet there is ſomething in it, that deſerves to be conſidered; eſpecially ſince we obſerve not, that the late anatomical diſcoveries of the motions of the chyle and lymphatick liquor, by formerly unknown ways, in newly detected veſſels, hath yet made men cure diſeaſes much better than before. Not that I think, that anatomical and pathological diſcoveries will not, in proceſs of time (when the *hiſtoria facti* ſhall be fully and indiſputably made out, and the theories thereby ſuggeſted, clearly eſtabliſhed) highly conduce to the improvement of the therapeutical part of phyſick; but yet this obſervation may make it the more reaſonable to beware of relying ſo much upon the yet diſputable opinions of phyſicians, as to deſpiſe all practices, though uſually ſucceſsful, that agree not with them: for of ſuch our author ſpeaks well, *In omnibus ejuſmodi cogitationibus in utramque partem diſſeri poſſe, itaque ingenium & facundiam vincere: morbos autem non eloquentiâ ſed remediis curari; quæ ſi quis elinguis uſu diſcreta benè norit, hunc aliquanto majorem medicum futurum, quam ſi, ſine uſu, linguam ſuam excoluerit.* And *Paracelſus* ſpoke well too, if he ſpoke truly, when in one of his prefaces, ſpeaking to thoſe, whom he invited to hear him expound his books of phyſick and chirurgery at *Baſil*; *Illos tamen* (ſaith he of his formerly mentioned books) *non aliorum more ex Hippocrate aut Galeno, aut quibuſlibet emendicatos, ſed quos ſumma rerum doctrina, experientia atque labore aſſequutus ſum, proinde ſi quid probaturus, experimenta, ac ratio, auctorum loco, mihi ſuffragantur.*

Preface, lib. 1.

Piſo de Medic. Braſil. lib. 2. c. 1.

Georg. Ent. in Epiſtol. præfix. Exercit. Harvei de gen. animal.

Celſ. præfatione ad Lib. 1.

A comparison of the empirick part of phyſick with the rational.

IT would, *Pyrophilus*, I fear, be tedious to trouble you here with all, that I have met with in good authors, applicable to my preſent ſubject, and the deſign I have been proſecuting in favour of external remedies: but yet one paſſage there is, which doth ſo notably confirm what we have delivered, as well touching the efficacy of ſimple medicines, as the great cures, that may, in divers caſes, be performed by outward applications, that I muſt not here omit the mentioning of it; as I find the epiſtle written out of *Peru* to the inquiſitive *Monardes*, in theſe words: *In urbe Poſto, ubi aliquot annis vixi, omnis generis morbos Indus quidam curabat ſolo cujuſdam plantæ ſucco artubus & parti affectæ illito. Ægros deinde ſtragulis egregiè tegebat ad ſudorem provocandum: ſudor è partibus illitis emanans merus ſanguis erat, quem linteis pannis abſtergebat, atque ita in curatione pergebat, donec ſatis ſudaſſe putaret, optimis interea cibis eos alens. Eo remedio multi morbi deplorati curabantur, imo ægri juniores & robuſtiores ab ejus uſu fieri videbantur, ſed neque pretio, neque precibus, neque minis unquam efficere potuimus, ut eam plantam nobis demonſtraret:* 'In the city *Poſto*, where 'I lived certain years, a certain Indian cured 'all ſorts of diſeaſes by the juice of one plant 'alone, wherewith he anointed the limbs and 'any other part particularly affected, and then 'covering them warm with blankets, provoked 'ſweat. The ſweat, that came from the parts 'ſo daubed, was meer blood, which he wiped off

Petrus de Oſma in epiſt. ad Monard. quæ extat in libello de ſimplicibus medicamentis ex Occidentali India delatis.

'off with linnen cloths, and ſo he proceeded 'until he thought they had ſweat enough. In 'the mean time he gave them diet, that was 'moſt nouriſhing. With this remedy many 'deſperate diſeaſes were cured, and the ſick 'perſon upon the uſe of this phyſick improv-'ed, ſo as to appear younger and luſtier after 'it. But we could never prevail, neither by 'money, nor intreaty, nor foul means, upon 'him to ſhew us the plant.'

CHAP. XI.

Of other extraordinary medicines, which work by magnetiſm, tranſplantation, &c.

BUT, *Pyrophilus*, beſides ſuch external medicines, as work after the manner of thoſe I have heretofore mentioned, we may poſſibly without abſurdity, provided we do it without credulity, inquire, whether there may be yet a ſort of others, that operate in a more wonderful and extraordinary way? And it would not perhaps be altogether unworthy the experiment, to try, whether or no there may not ſometimes be performed, ſuch cures, as are wont to paſs either for fabulous or magical; ſome of them being to be done without exhibiting, or applying any thing immediately to the patient, and others by ſome ſuch unknown ways as thoſe, which chymiſts call, either magnetiſm, or tranſplantation: ſuch as are the cures reported to be performed by the weapon-ſalve and ſympathetick powder, and ſuch as is that cure of the yellow jaundice (mentioned with ſome verification by *Paracelſus*) wherein ſeven or nine cakes (for it muſt, forſooth, be an odd number) are made up with the newly emitted and warm urine of the patient, and the aſhes of aſhwood, and buried for ſome days in a dunghill. For it is not only by the eaſy and ſuperſtitious vulgar, that the poſſibility of performing ſuch cures, by tranſplantation, or ſome other magnetical way (as they pleaſed to call it) hath been believed. For within the compaſs of my own ſlender reading, I find, that divers eminent phyſicians have both made uſe of, and commended magnetical remedies.

The cure of an ulcer in the bladder by ſympathetick powder.

WHAT is to be thought of the ſympathetick powder, I confeſs I am as yet in doubt; but however I ſhall take this occaſion to inform you, that a very honeſt gentleman, whom his pen has made known to a great part of the learned men and virtuoſi in *Europe*, complaining often to me, that though he were much troubled with that ſad diſeaſe, the ſtone in the bladder, yet he was more inceſſantly tormented with an ulcer he had in the ſame part, (all the ſearching medicines, that he took to diſſolve, as he hoped, the ſtone, exaſperating the ulcer:) I one day adviſed him to make uſe of the powder of ſympathy, upon ſome of the ulcerous matter he voided with his urine; the remedy being ſuch, as, if it had a magnetick virtue, might do him good; and if it had none, could not prejudice him. A while after, I received, both from him in a letter, and from his phyſician, very great thanks for the advice; the patient having, ſince the uſe of the powder, been eaſed of the diſtinct pain he was put to by the ulcers; and this relief laſted, if I miſremember not, above a year, and how much longer I know not. But I ſhall not inſiſt either upon this, or upon the teſtimonies and relations of *Paracelſus*, *Helmont*, *Goclenius*, *Burgravius*, nor even the modern Roman doctor, *Servius*, nor any of the other authors, that do profeſſedly take upon them the defence of the weapon-ſalve, by reaſon of what we have elſewhere to write to you, by way of examination of that ſalve, and the ſympathetick powder, though I deny not, in ſome trials I have found them available; yet beſides what I have newly related, I have ſeen ſometimes ſomething follow upon the uſe of ſympathetick powder, that did incline me to think, that ſometimes it might work upon cures. But I ſhall alledge ſomething of more unexpected credit; and firſt *Dominicus Panarola*, now profeſſor of phyſick at *Rome*, in his newly divulged *Faſciculus Arcanorum*, preſents us two inſtances to our preſent purpoſe, in theſe words: *Mira*, (ſays he) *quotidie reperiuntur in medicina ad confirmationem operis, quod doctiſſimus phyſicus, Petrus Servius* (the ſame we lately mentioned) *complevit de unguento armario, ſciendum eſt quod pecia ſanguine imbuta ſub cineribus calidis poſita menſes ſiſtit, experimento pluries comprobato: quinetiam magiſter meus Petrus Caſtellus* (whoſe name his late *Anatomy of the Civet Cat*, and other writings have made famous) *aiebat ſe expertum fuiſſe hæmorrhoides, ſi tangantur tuberoſa radice chondrilla ſiccari, ſi chondrilla ſiccetur; corrumpi verò, ſi corrumpatur: quapropter ſub camino exſiccanda ponitur poſt hujuſmodi tactum chondrilla tuberoſa.* 'Wonderful things are daily found out 'in phyſick to the confirmation of the operation 'of the learned naturaliſt *Petrus Servius*'s wea-'pon-ſalve. For he aſſured us, that a piece of 'cloth dipt in the blood, and put under hot 'aſhes, ſtops the monthly flux; the experiment 'having been often proved. And my maſter 'Petrus Caſtellus affirms, as he found by expe-'rience, that the hæmorrhoids, if they were 'touched with the tuberous root chondrilla, did 'dry away, if the chondrilla dried, and did run 'to corruption, if the chondrilla was corrupted. 'And therefore, after ſuch touching of the hæ-'morrhoids, the chondrilla was uſually put to 'dry in the chimney.' The learned *Salmuth*, in his obſervations, furniſhes us with an example of a moſt violent pain of the arm, removed by tranſplantation: they did beat up red corals with oaken leaves, and having kept them on the part affected 'till ſuppuration, they did in the morning put this mixture into an hole bored with an augur in the root of an oak, reſpecting the eaſt, and ſtopt up this hole with a peg, made of the ſame tree: from thenceforth the pain did altogether ceaſe; and when they took out the amulet, immediately the torments returned ſharper than before. A great and excellent lady (a near kinſwoman, *Pyrophilus*, of yours and mine) and very far from credulous, confeſſed to me, as did her ſervants alſo, that with the above-mentioned remedy of aſhes and urine, ſhe was not only once cured of the yellow jaundice, by a friend of hers, that had obſerved, that ſhe had been fruitleſly vexed by a tedious courſe of phyſick, preſcribed by the famouſeſt doctor then in *England*, but that afterwards relapſing into that ſame diſeaſe, ſhe had cured herſelf by the ſame

The effects of weapon-ſalve, and other magnetical remedies.

Panarol. Faſc. arcan. 1.

Centur. 3. *obſervat.* 34.

ſame remedy. I remember, that being ſome years ſince brought almoſt to the brink of the grave, by a ſudden effuſion of blood within my body, from which, without a ſignal mercy of God, I ſhould not have recovered; among other men ſkilled in phyſick that came to aſſiſt me in that danger, I was viſited by a Galeniſt of much repute, whoſe pale looks inviting me to inquire, what it was that ailed him, he anſwered me, That he had not long before been deſperately ſick of an obſtinate maraſmus, which, notwithſtanding all the remedies he could uſe, did daily ſo conſume him, that he appeared but a ſkeleton; whereupon having found the uneffectualneſs of ordinary remedies, and being hopeleſs of being relieved by them, he reſolved to try a ſympathetick medicine, which I remember my ſelf to have met with in *Hartman*. He took then an egg, and having boiled it hard in his own warm urine, he with a bodkin perforated the ſhell in many places, and then buried it in an ant-hill, where it was left to be devoured by the emmets; and as they waſted the egg, he found his diſtemper to leſſen, and his ſtrength to increaſe, inſomuch that he now conceived his diſeaſe to have quite left him.

Obſervations of the tranſplantation of diſeaſes.

Riverius *cent.* 4. *obſerv.* 63.

THE experienced *Riverius* in his laſt obſervations (newly publiſhed ſince his death) has two notable examples to our preſent purpoſe. For firſt he tells us, that the eldeſt drughter of a great officer in *France* was ſo tormented with a paronychia for four days together, that the pain made him paſs the night ſleepleſs: whereupon having, by *Riverius*'s order, put her finger into a cat's ear, within two hours ſhe was delivered from her pain, and her whole hand, which before was tumid, unſwelled again, except the finger, which it ſelf was out of pain.

Riverius *cent.* 4. *obſerv.* 19.

The other caſe was of a counſellor's wife, who by the ſame remedy was cured of a panaritium (which had for four days vext her) in a much ſhorter time than the other; namely, within a quarter of an hour. But that which chiefly makes theſe ſtories pertinent to our preſent occaſion, is this notable circumſtance, that in both the caſes, the cat was ſo manifeſtly put to pain, that *Riverius* thought it had attracted to itſelf the morbifick matter, from which it freed the patient. For in the former of theſe two caſes, the cat loudly complained of the pain he felt; and the other was, in that ſhort time the cure was performing, put to ſo much pain in his ear, that two men were hardly able to hold him faſt, he ſtruggled ſo forcibly. And theſe two relations of *Riverius* may, though there be ſome diſparity in the caſes, give ſome countenance to what might otherwiſe be diſtruſted in the obſervations of the induſtrious *Petrus Borellus*; where he ſays, *Podagra mirè levatur, ſi catelli cum podagrico recumbant, morbum enim contrahunt, adeò ut vix incedere queant; ager verò levamen ſuſcipit.* 'The gout is 'ſtrangely eaſed, if puppies lie with the perſon, 'that hath the gout; for they contract the 'diſeaſe ſo as not to be able to go, but the 'patient thereby finds eaſe.' Which perhaps he may have been induced to write, by the ſtory that goes of that odd chymiſt, *Robert Fludd*'s having tranſplanted the gout of one of his patients, by making him often ſleep with a dog, that was fond of him, who thereby became ſubject to ſuch periodical fits of the gout, as the maſter had been troubled with.

In hiſtoriar. & obſerv. 3. *medico-phyſic. cent.* 3. *obſerv.* 28.

[AND ſince I begun this chapter, and met with theſe objections, diſcourſing of this matter with a judicious perſon, well ſkilled in phyſick, and whom his learned writings have made eminent, he told me, that he had, not very many months ſince, ſeen a cure by tranſplantation, performed on the ſon of one, that was wont to make chymical veſſels for me. And becauſe the obſervation is conſiderable, that there might be no miſtake in it, he has pleaſed to ſet it me down in writing (atteſted with his annexed name) which enables me to preſent it to you in his own words: *N. N.* of *N.* potter, had a ſon, who was long ſick of the king's-evil, which ſwelled much, and broke into ſores at laſt, which he could by no ordinary means heal. The old man had then a dog, which took an uſe of licking the ſores; which the dog continued ſo long, till he waſted the very kernels of ulcers, that were knit in with the veins, and perfectly cured the ſore, but had the ſwelling tranſplanted to himſelf, ſo that he had thereupon a great ſwelling, that aroſe and continued on his throat. The lad was thereby freed, ſo continued to be till 1660, and for aught I know is ſo this day. This I ſaw, being there at that time to view the clays, and beſpeak retorts of the old man. *]

AND to confirm the credibility, as well as increaſe the number of our magnetical ways of cure; I ſhall add, that Sir *Francis Bacon* himſelf records, with great ſolemnity, his own having been freed, not only from very many new warts, but from one almoſt as old as he, by a piece of lard with the ſkin on it, which after having rubbed upon them, was expoſed out of a ſouthern window to putrefy. And therefore though the vanity and ſuperſtition of the authors, that ſpeak of magnetick remedies, and the impertinent circumſtances, that are uſually preſcribed, as neceſſary to their effectualneſs, do generally and juſtly enough make ſober men deſpiſe, or at leaſt ſuſpect ſuch unlikely ways of cure; yet in conſideration of inſtances lately produced (to which we may perhaps elſewhere add ſome others) and becauſe divers men, as well phyſicians as others, have ſeriouſly aſſured me of their having been ſome

Cent. X. *exp.* 997.

* Some years ſince the preſent eſſay was written, I lighted on the 66th obſervation of the induſtrious *Bartholinus*, 3d cent. and the 53d obſervat. of his 6th century; in both which places giving inſtances of the tranſplantation of diſeaſes, he mentions, beſides ſome of thoſe examples delivered by us, divers others; for which I am willing to refer you to the alledged places: only in the laſt of theſe obſervations delivering ſomething as upon his own knowledge, (which he does not in the reſt of the inſtances) that much confirms what we have mentioned concerning *Fludd*. We ſhall annex it in his own words: *In catello Mileſio avi noſtri materni, quem jam olit in ædibus ſuis avunculus meus ſuſpiciendus M Jacobus Finckius Phyſ. P. P. & academiæ noſtræ ſenior, evidentius hæc patuit trahendi facultas. Colico dolore torquebatur avunculus, canis ventri impoſitus, quum incaluiſſet, urgebat exitum, vomuit vehementer, & tormina colica avunculi remiſerunt. Ancilla ejuſdem in dolore dentium eundem canem genis appoſuit, ſenſitque levamen, ſed canis dolorum impatientia hinc inde curſitare & latrare. Idem expertus eſt ſcriba in colli tumore.*

ſome of them eye-witneſſes, and others, performers of ſuch cures; I am apt to think it fit, that a ſevere indeed, but yet further trial be made of phyſical experiments of this kind. And I cannot but commend the curioſity of Dr. *Harvey*, who, as rigid a naturaliſt as he is, ſcrupled not often to try the experiment mentioned by *Helmont*, of curing ſome tumours or excreſcencies, by holding on them for a pretty while (that the cold might throughly penetrate) the hand of a man dead of a lingring diſeaſe; which experiment the doctor was not long ſince pleaſed to tell me, he had ſometimes tried fruitleſly, but often with good ſucceſs. Nor doth the grand objection againſt ſuch experiments, namely, that ſuch or ſuch a perſon, having once made trial of them, found them not ſucceed, ſeem at all to me, alone, of weight enough to make ſuch experiments, or thoſe other improbable ones formerly mentioned, totally rejected. Becauſe, if they really do ſometimes ſucceed, though ſometimes they chance to fail, yet that poſſibility of their ſucceeding may ſufficiently evince, that there are really in nature medicines, that work after that extraordinary manner. And I ſee no reaſon, why it ſhould be more required of thoſe medicines, that work at diſtance from the patient, (or at leaſt are not taken at mouth, or injected otherwhere) only by ſubtile effluvia, that they ſhould always cure, than it is exacted of vulgar remedies, from which we might reaſonably expect more conſtant effects, becauſe of their being either inwardly given, or more immediately, or at leaſt, more durably applied to the patient. And if rhubarb be juſtly affirmed to be an excellent medicine in looſeneſſes, though we daily in *Ireland* ſee many ſwept away of thoſe diſeaſes, in ſpight of the uſe of rhubarb and mirabolans, with other aſtringent remedies to boot: and if quickſilver be, not unreaſonably, by moſt of our phyſicians, eſteemed and employed as an effectual remedy againſt venereal diſeaſes, becauſe it ſometimes removes them, though *Fernelius*, *Montanus*, and many other learned authors tell us, as they ſay upon their own experience, that (though it often palliate thoſe diſtempers) it very ſeldom cures them: nay, and if diaphoreticks are ſtill eſteemed ſuch by the generality of phyſicians, though few ſudorificks will cauſe ſweat in all bodies, and ſcarce any in ſome bodies; I ſee not, why theſe remedies, that work, as it were, by emanation, may not deſerve the name of medicines, if they ſometimes unqueſtionably ſucceed, though they ſhould not always prove ſucceſsful ones; nor why they ſhould, notwithſtanding their ſometimes not ſucceeding, be laid aſide; eſpecially ſince theſe ſympathetical ways of cure are moſt of them ſo ſafe and innocent, that though, if they be real, they may do much good, if they prove fictions they can do no harm; unleſs by accident, as in caſe the patient ſhould ſo ſingly rely on them, as to neglect (which he need not all) other helps to recover.

The ſometimes not ſucceeding of magnetical medicines no ſufficient cauſe to abandon their uſe.

CHAP. XII.

BUT you will now perhaps demand, *Pyrophilus*, how the naturaliſt, as ſuch, can contribute to the credit or advancement of the mentioned ways of curing diſeaſes, without the wonted weakning and painful evacuations? In anſwer to this queſtion, I muſt put you in mind, that it would be no new thing for naturaliſts, not profeſſedly phyſicians, to treat of this ſubject; and that the naturaliſt may afford good hints to the practitioner of phyſick, both upon divers other accounts already touched upon, and by trying upon brutes variety of hitherto untried medicaments or remedies, and by ſuggeſting to him both the events of ſuch trials, and alſo what hath been already obſerved about the cures of diſeaſes incident to beaſts. For though (as we formerly told you) there are ſome things, that are not equally poiſonous, as others not equally ſafe, to man, and to ſome brutes, ; yet there are other beaſts, eſpecially dogs, and monkeys, whoſe bodies are, by many poiſons, affected almoſt like thoſe of men. And ſince, according to the rule, *Periculum faciendum eſt in vili anima*, many things may be very well tried on ſuch creatures, that we dare not at firſt venture to try on men; we may give dogs poiſons, only to try the virtue of our antidotes; and we may give them wounds, to make trial of the efficacy of the weapon-ſalve and ſympathetick powder; ſince divers of my friends (as I have intimated above) aſſure me, that they have ſome of them ſeen, and others performed cures of horſes, lamed by pricking, by ſticking the nails, that hurt them, into weapon-ſalve; which, for that very uſe, among others, ſome of them are wont to carry about them in ſilver-boxes. When oxen and ſuch like cattle are troubled with that diſeaſe, which makes them continually turn about in one place, (and is therefore called the turning-evil, or ſturdy) a common remedy here in *England*, as graziers that make uſe of it inform me, is to caſt down and tie faſt the ſick beaſt, and then to open his ſkull a good way, (or, if need be, take off a round piece of it over the place ſuppoſed to be affected) and at the open place to take out a little bag or bladder, which is uſually found to lie near the membranes of the brain, and to be full of water and blood, and then leiſurely to heal up the hurt. And this cure is much commended, as both common and eaſy, by our experienced *Markham*. In goats likewiſe, that are much ſubject to the dropſy, the huſband-man ventures to ſlit, and let out the water under the ſhoulder. And divers hazardous operations in ſurgery, ſuch as are arteriotomy, the exſection of the ſpleen, and other parts, were, or ſhould have been firſt attempted upon brutes, and then practiſed on human bodies. And in imitation of theſe, it is likely, that divers other experiments, of good uſe in ſurgery, may be diſcovered for the relief of man, without endangering him in proſecuting ſuch diſcoveries. And to ſay nothing of the known practice of ſpaying ſwine, and bitches; in the neighbourhood of a country-houſe of mine, in the weſt of *England*, and probably in divers other parts, ſome experienced ſhepherds have an odd way of caſtrating male ſheep, eſpecially lambs, when they are grown ſo old, that it is thought dangerous to geld them

Inſtances of divers cures upon brutes, and how theſe are applicable to men.

them the common way. A ſervant of mine, that deals much in cattle, and had lately divers ſheep ſwigged (as they call it) after this manner, tells me, that it is thus done: the beaſt, on whom the operation is to be performed, being held by a ſtrong man with his belly upwards, another man draws a ſtring, as firmly as he can (tying it with a knot or two, to prevent its yielding or ſlipping off) about the teſticles, as if he meant, by drawing that ſtring, to cut them off; and then anointing the part with a little freſh butter, or ſome ſuch like thing, he lets the ram go to feed; which, for the moſt part (notwithſtanding the anguiſh of this ligature) he will begin to do in a ſhort time: And within two or three days, the teſticles, being by the ſtrict ligature denied the nutriment and ſpirits, that were wont to be conveyed to them, will grow ſo rotten, as either, together with the ſtring, to fall off, or be very eaſily pull'd off, ſometimes ſtinking very rankly like carrion. And even among thoſe things, that are already practiſed by farriers, ſhepherds, and graziers, there are many ſuch things, as we have newly mentioned, which may ſerve either to inrich or illuſtrate the way of curing human bodies: their ignorance and credulouſneſs, together with the liberty and meanneſs of thoſe creatures they phyſick, give them leave to venture on any thing, having made them try upon horſes, and cattle, many ſuch things, as phyſicians dare not try upon men and women. And among thoſe many extravagant things, ſome, as it often happens, have ſucceeded ſo proſperouſly, as to deſerve to be conſidered by the ſkilfulleſt phyſicians; ſome of whom might, without diſparagement to their profeſſion, do it an uſeful piece of ſervice, if they would be pleaſed to collect and digeſt all the approved experiments and practices of the farriers, graziers, butchers, and the like, which the ancients did not deſpiſe, but honoured with the titles of *Hippiatrica*, and *Veterinaria*; and among which, if I had leiſure, divers things may be taken notice of, which might ſerve to illuſtrate the *methodus medendi*. As to give you but one inſtance, which lately occurred to me, the uſefulneſs of letting blood in ſome caſes, which is ſo ſeverely condemned by many chymiſts, and the efficacy of a ſmall, if ſeaſonable, evacuation, which can ſcarce be conceived to do more than alter the courſe of the blood, may be illuſtrated by the ſtaggers in horſes, and the cure of it. For I have ſeen a coach-horſe, ready to drop down dead of his diſeaſe upon the high-way, by having his gums rubbed with the coach-whip, till the blood appeared, relieved almoſt in a moment ſo much, that though he were not well able to ſtand before, yet he was immediately able to go on, and draw the coach with his fellows

That the handling of phyſical matters was anciently thought to belong to the naturaliſt. Celſus *in præf. l. 1.*

CHAP. XIII.

THE next thing we are to obſerve to you, *Pyrophilus*, and on which its nature and importance will ingage us ſomewhat long to inſiſt, is this; that the handling of phyſical matters was anciently thought to belong to the naturaliſt; as we are clearly informed by the judicious *Celſus*, in that memorable paſſage, where he ſpeaking of the origin of phyſick, *Primo* (ſays he) *medendi ſcientia ſapientiæ pars habebatur; ut morborum curatio & rerum naturæ contemplatio ſub iiſdem authoribus nata ſit: ſcilicet his hanc maxime requirentibus, qui corporum ſuorum robora, inquieta cogitatione nocturnaque vigiliâ minuerant.* 'At the firſt, phyſick was accounted part of philoſophy, ſo that 'the cure of diſeaſes, and the contemplation 'of nature, did both ariſe under the ſame au'thors; thoſe being moſt ſet upon medical 'inquiries, which had made their bodies infirm 'by diſquieting thoughtfulneſs, and nocturnal 'watchings.' He adds, that many of the profeſſors of philoſophy, eſpecially *Pythagoras*, *Empedocles*, and *Democritus*, and that *Hippocrates* (whom ſome think to be the diſciple of the laſt named) was the firſt, that ſever'd phyſick from philoſophy, and made it a diſtinct diſcipline. And this apology for the enſuing diſcourſe being thus premiſed to it, I ſhall further anſwer, that I ſhould perhaps be obliged to exceed the limits of an eſſay, if I ſhould in this diſcourſe inſiſt on every thing, upon whoſe account the naturaliſt may aſſiſt the phyſician, if he be barely a *medicus* to cure diſeaſes, which that you may the more readily believe, I ſhall ſelect and proſecute ſome of theſe things in the remaining part of this eſſay.

That the rejecting ſpecificks, becauſe they make no viſible evacuation, is irrational.

AND firſt I ſhall repreſent to you on this ſubject, that the account, upon which phyſicians are wont to reject, if not deride, the uſe of ſuch ſpecificks, as ſeem to work after a ſecret and unknown manner, and not by viſibly evacuating peccant humours (or by other ſuppoſedly manifeſt qualities) being generally this; That they ſee not, how the promiſed effects can well be produced by bodies, that muſt work after ſo peculiar and undiſcerned a manner; this being, I ſay, the great thing, that hinders phyſicians from endeavouring to find, or ſo much as being willing to make uſe of remedies of this ſort, the naturaliſts may do much towards the removal of this impediment, by ſhewing out of ſuch things, as may be met with or performed within the macrocoſm, that ſuch, or at leaſt as ſtrange operations, as are aſcribed to theſe ſpecificks, are not without example in nature; and conſequently ought not to be rejected, barely as being impoſſible. And indeed the phyſiology, wherewith phyſicians as well as others are wont to be imbued in the ſchools, has done many of them no ſmall diſſervice, by accuſtoming them to groſs apprehenſions of nature's ways of working. Whence it comes to paſs, that not a few even learned doctors will never expect, that any great matter ſhould be performed in diſeaſes, by ſuch remedies, as are neither obvious to the ſenſe, nor evacuate any groſs, or at leaſt ſenſible matter. Whereas, very great alterations may be wrought in a body, eſpecially if liquid, as is the blood and peccant humour, without the ingreſs or egreſs of any viſible matter, by the inteſtine commotion of the parts of the ſame body acting upon another, and thereby acquiring a differing motion, location, (if I may

ſo ſpeak) or figure, which, with the other qualities and effects reſulting thence, may alter the motion and texture of the liquor, and thereby produce great changes in the body that harbours it. How much an unperceived receſs of a few ſubtile parts of a liquor may alter the nature of it, may be gueſſed at, by the obvious change of wine into vinegar; wherein upon the avolation (or perhaps but the miſplacing) of ſo little of the ſpirituous and ſulphureous part, that its preſence, abſence, or new combination with the other parts is not diſcernable to the eye, the ſcarce decreaſed liquor becomes of a quite differing nature from what it was. And though in *England* this degeneration be not wont to be ſo ſuddenly performed, by reaſon of the coldneſs of the climate, yet in hotter countries the change is much more ſpeedily made. As in *Braſil*, the above mentioned *Piſo* informs us, that the expreſſed juice of the ſugar-canes, which by coction, and farther ordering, would be certainly brought to ſugar, will of it ſelf keep ſweet but about four and twenty hours, and then begin to ſour, and be altogether unfit to make ſugar of, though very fit to turn into good vinegar. And this I find confirmed by a modern and applauded French writer, in his deſcription of ſome parts of the *Weſt-Indies*, inhabited by his nation: and relations of the ſame ſort, concerning the haſty ſouring of ſome other liquors in *America*, I have had from our Engliſh travellers and planters. And in the *Eaſt-Indies*, *Linſchoten* tells us of a change much more ſudden: for ſpeaking of the formerly mentioned *Sura*, or liquor, afforded by the wounded coco tree; 'The ſame 'water (ſays he) ſtanding but one hour in the 'ſun is very good vinegar, and in *India* they 'have none other.' And that even very hurtful liquors (and why not then ſome peccant matter in the body?) may after the like manner change their nature, may appear by what we have formerly mentioned, and is unanimouſly affirmed by credible writers of ſeveral nations, concerning the juice of mandioca, which, being poiſon, when it is firſt expreſſed, does in a few hours, by fermentation, purge it ſelf, and loſe its pernicious nature. That alſo by the bare ingreſs of ſome ſubtile and not viſible matter, ſuch inteſtine commotions may be excited in liquors, may appear by the ſouring, which has been often obſerved upon great thunders to happen, not only to wines, but to other vinous liquors alſo; as I lately received from a great maſter of variety of liquors a complaint, that by ſome thunder, which happened here a few weeks ſince, almoſt all the beer and ale in the neighbourhood was ſpoiled. And I remember, that when I returned out of *Italy* through *Geneva*, there happened in that place an earthquake; upon which, the citizens complained, that much of their wine was ſoured, though I, that lodged in the higheſt part of the town, ſaw nothing to make me believe, that the bare ſuccuſſion of the earth was capable to produce ſo great and ſudden an alteration in the wine.

That great changes may be made by only miſplacing, without any evacuation of the parts.

Lib. 4. cap. 10.

The making of vinegar is an inſtance of this truth, eſpecially in the Indies.

chap 56.

See Piſo, l. 1.

In the effects of thunder and earthquakes.

THAT ſuch inviſible corpuſcles may paſs from amulets, or other external remedies, into the blood and humours, and there produce great changes, will ſcarce ſeem improbable to him, that conſiders, how perſpirable, according to *Hippocrates*, a living body is; and that a vegetable and animal bodies, whoſe texture is more looſe and open, may well be ſuppoſed to ſend forth expirations, ſince even divers minerals are found to do the like; as may appear by the odorable ſteams of rubbed brimſtone, and amber, by the corpuſcles, which perform the magnetick operations, by the emetick quality imparted to liquors by the glaſs of antimony, and by *crocus metallorum* barely infuſed in them, without ſenſibly loſing any thing, either of their bulk or weight; and by the virtue of killing worms, wherewith wine, and even water has been, not only by *Helmont*, but by divers other phyſicians, obſerved to be enriched, after a quantity of quick-ſilver has been for ſome hours ſhaken in it, though without any ſenſible deperdition of the ſubſtance of the mercury. And indeed I have ſomewhat wondered, that many learned modern phyſicians, either out of an affected ſeverity, or perhaps animoſity againſt chymiſts, overlook, or even deride, all operations of this nature; ſince I remember *Galen* himſelf not only confirms the like doctrine, by his reaſons and authority, but delivers a very ſtrange example of it; for, under the title of *Glychyſida*, treating of peony, he thus diſcourſes: *Eſt præterea omnino reſiccatoria; Eapropter haud deſperaverim eam ex collo pueris ſuſpenſam merito comitialem morbum ſanare. Equidem vidi puellum quandoque octo totis menſibus morbo comitiali liberum, ac poſtea fortuna cum quod à collo ſuſpenſum erat decidiſſet, protinus denuo convulſione correptum, rurſuſque ſuſpenſo in locum illius alio, inculpatè poſtea egiſſe. Porro viſum eſt mihi ſatius eſſe rurſum id collo detrahere, certioris experientiæ gratiâ: id cum feciſſem, ac puer iterum eſſet convulſus, magnam recentis radicis partem ex collo ejus ſuſpendimus, ac deinceps prorſum ſanus effectus eſt puer, nec poſtea convulſus eſt. Rationabile itaque erat, aut partes quaſpiam à radice defluentes, ac deinde per inſpirationem attractas, affectos ita locos curare, aut aërem à radice aſſiduè mutari & alterari. Nam hoc pacto ſuccus Cyrenaïcus collumellam phlegmone affectam juvat, & melanthion frictum palam catarrhos & coryzas deſiccat. Si quis id in calidum linteum rarum liget, aſſidueque calorem ex eo per inſpirationem in nares attrahat. Quin etiam ſi pluribus linis, & maximè marinæ purpuræ, collo viperæ injectis, illis viperam præfoces, eaque poſtea cujuſpiam collo obvincias, mirifice profueris tum pariſthmiis tum omnibus iis, quæ in collo expullulant:* 'Beſides, 'it is altogether drying; and therefore I ſhould 'not deſpair, that it, being hung about childrens 'necks, might cure the falling-ſickneſs in them. 'I truly ſaw a lad, that ſometimes would be 'eight whole months free from the falling-'ſickneſs, and then, when by chance this fell 'from off his neck, he became immediately ſur-'prized with a fit; and again, hanging another 'root in its place, he would continue well. 'Therefore, for experiment ſake, I thought 'good to take it again from his neck, which 'when I had done, and found, that the lad fell 'into

Divers inſtances to prove, that inviſible corpuſcles may paſs from amulets, and cauſe great alterations in the juices of a man's body.

De Simp. Med. facultatibus, l. 6.

Galen's example of peony-root, &c.

'into his former convulſions, we took a great 'piece of a green root, and hung it about his 'neck, and from that time he continued well, 'and felt no more convulſions. It was there-'fore moſt probable, that either certain parts 'did exhale from the root, and were drawn 'into the body by inſpiration, which did ſo 'work upon the affected parts; or that the 'ambient air was continually changed and al-'tered by the root: for after this manner the '*ſuccus Cyrenaicus* cures the *phlegmone* upon 'the *uvula*; ſo catarrhs and other rheums are 'dried up by melanthium, if it be tyed up 'warm in fine linnen, and the hot fume of it 'be drawn up into the noſtrils by inſpiration. 'Nay, if you ſtrangle a viper with divers ſorts 'of threads, and eſpecially with the ſea-purple, 'and then you tye thoſe threads about the neck 'of your patient, you ſhall cure the ſwelling of 'the almonds of the ears, and all other ſwel-'lings in the neck.' Nay, that ſuch inviſible bodies, by paſſing through groſſer ones, and thereby changing the motion and nexus or juncture of their parts, may produce laſting alterations in the textures (though it be a paradox) ſeems not at all to me impoſſible. For we find the moſt fluid body of quickſilver has been ſometimes, (I ſay ſometimes) and therefore may, without ſenſible increaſe of bulk, be coagulated by a metalline exhalation, ſo as to be cut like lead, and to retain that ſolidity, till by ſome art or other it be reduced to its priſtine fluidneſs. You may be inclined to think, that the hard and ſolid body of iron has a permanent alteration made in its texture, if you hold a needle during a competent time near the pole of a vigorous loadſtone without touching it. For the magnetical effluvia (as may very probably be conceived) will ſo diſpoſe the parts of the neareſt extreme of the needle, as that they ſhall admit the ſteams, that come from one of the poles of the loadſtone, and not thoſe that come from the other: whereas by ſkilfully holding it to the contrary pole of the ſame ſtone, the internal pores, and conſequently the texture of the needle, will preſently be quite otherwiſe diſpoſed, in reference to the magnetical effluvia; as we more fully declare in another eſſay, where we ſhall, I ſuppoſe, alſo perſuade you, that the effects of the loadſtone are performed by ſubtle bodies iſſuing from, or paſſing through it. What we have in the former diſcourſe told you concerning our having at pleaſure changed the poles of a load-ſtone, by help of the magnetical effluvia of the earth, may let you ſee, that in ſtones alſo ſuch alterations are poſſible to be made. And in the next eſſay ſave one, we ſhall give you another inſtance pertinent to our purpoſe. For if you heat a ſlender piece of ſteel (as a graver, or the like) red hot, and ſuffer it to cool leiſurely in the air, it will continue flexible enough, and of ſo ſoft a texture, that you may eaſily make impreſſions on it with any hardned ſteel: but if, inſtead of cooling it thus ſlowly, you knock it into ſuch a dry body, as we ſhall there name to you, it will immediately grow ſo hard, as to be brittle. Which alteration, whether it be reſolved to proceed from the particular effluvia of the body, into which it is knocked, or barely from the ingreſs of the corpuſcles of cold, (if any ſuch there be) it will be however an inſtance not unfit for our purpoſe. And thoſe, *Pyrophilus*, that are converſant in glaſs-houſes, may eaſily obſerve, that glaſs acquires a more or leſs brittle texture, according as (to ſpeak in the glaſsmen's language) it is baked. For if, after glaſſes are blown, they be quickly carried into the open air, they wont to be much more ſubject to break, than thoſe, that after they are faſhioned, are placed in a kind of very long oven, (which is wont to be built over the furnace, wherein the materials, whereof the glaſs is made, are kept in fuſion) and are by ſlow degrees refrigerated, and not till after ſome hours expoſed to the open air: for whether this difference of brittleneſs, and conſequently of texture, be aſcribed to the interrupted tranſcurſion of ſome etherial matter, through the pores of the glaſs, or to the inſinuations of the atoms of the cold; or to this, that the particles of the glaſs agitated by the heat were ſurprized by the cold, before they could make an end of thoſe motions, which were requiſite to their diſpoſing themſelves into the moſt durable texture; it is evident enough, that it is by no groſs or viſible body, that this permanent difference of texture is produced. Of the like to which we may elſewhere give you examples in ſome other concretes. That alſo in an human body great alterations may be made by very ſubtile effluvia, appears evidently, not only by the inſtances we have formerly given of the efficacy of ſome outwardly applied remedies, but by divers other things; as that many are purged by the bare odour of potions; of which I have been aſſured, upon his own obſervation, by the experienced town-phyſician of *Plimouth*, Dr. *D.* and of which *Salmuth*, in his Obſervations, gives us an inſtance in a young gentlewoman, whom he ſaw more happily purged by the odour of a potion, drank by her ſiſter, than ſhe was that took the medicine. And the ſame author tells us of one Dr. *Pfeil*, an eminent phyſician, who was wont, when he had a mind to be purged, to go into ſome apothecaries ſhop, where electuaries electively purging were preparing, to which having a while ſmelt, they would by their odour, after his return home, work with him ſix or ſeven times, as if he had ſwallowed the medicine it ſelf. And *Henricus ab Heer*, in the twenty ninth of his formerly commended Obſervations, tells us of a woman, that not only was wont to be copiouſly purged by drinking beef-broth, but having by a fall broken her leg, uſed no other cathartick, than the bare odour of that ſort of broth. And very obſervable to our purpoſe is the operation of the air, all along the ridge of the high mountain of *Peru*, called *Pariacaca*, of which the learned Jeſuit *Joſeph Acoſta* relates, that though he went as well prepared as he could, to withſtand the operations uſually produced in travels, by that piercing air; yet when he approached to the top of the mountain, he was (notwithſtanding all his proviſion) ſurprized with ſuch fits, and pangs of ſtriving and caſting

Of purging by the order of potions.

Cent. 3. Obſer. 4.

Cent. 3. Obſer. 8.

Lib. 3. cap. 9.

Of the purging and vomiting quality of the air of the mountain Pariacaca.

ing, as he thought he ſhould caſt up his heart too; having, after meat, phlegm, and choler, both yellow and green, in the end with overſtriving caſt up blood; and continued thus ſick for three or four hours, till he had paſſed into a more temperate air than that of the top of the mountain; which runs about 500 leagues, and has every where, though not equally, this diſcompoſing property, having operated upon ſome of his companions, as well downwards as upwards. A greater proof of the power of the ſteams upon the body may be taken from the propagation of infectious diſeaſes, which being conveyed by inſenſible effluvia, from a ſick into a healthy body, are able to diſorder the whole oeconomy of it, and act thoſe ſad tragedies, which phyſicians do ſo often unſucceſsfully endeavour to hinder. But you will ceaſe to doubt, that corpuſcles, though ſo ſmall as to be below the ſenſe, ſhould be able to perform great matters upon human bodies, if you conſider, what alterations may be therein produced by the bare actions of the parts upon one another. This may appear by the effects of ſeveral paſſions of the mind, which are often excited by the bare, if attentive, thoughts of abſent things. In obſtinate grief and melancholy, there is that alteration made in the diſpoſition of the heart, and perhaps ſome other parts, by which the blood is to circulate, that the lively motion of that liquor is thereby diſturbed, and obſtructions and other not eaſily removed diſtempers are occaſioned. The bare remembrance of a loathſome potion does oftentimes produce in me (and I doubt not, but the like thought may have the like operation in many others) a horrour, attended with a very ſenſible commotion of divers parts of my body, eſpecially with a kind of convulſive motion, in or about the ſtomach. And what power the paſſions have to alter and determine the courſe of the blood, may appear yet more manifeſtly in modeſt and baſhful perſons, eſpecially women, when meerly upon the remembrance or thought of an unchaſte, or undecent thing, mentioned before them, the motion of the blood will be ſo determined, as to paſs ſuddenly and plentifully enough in the cheeks (and ſometimes other parts) to make them immediately wear that livery of virtue (as an old philoſopher ſtyled it) which we call a bluſh. And even by joy, if great and ſudden, I not long ſince ſaw in perſons of both ſexes, not only the cheeks and forehead, but it left (as to the lady) even the neck and ſhoulders dyed of that colour. And that paſſions may not only alter the motion of the juices of the body, but likewiſe make ſome ſeparation and evacuation of them, may appear in grief, which is wont, eſpecially in women, to make all the commotions requiſite to weeping; whereby oftentimes a conſiderable quantity of briny liquor is excluded at the eyes, under the form of tears, by which divers (eſpecially hyſterical) perſons are wont to find themſelves much refreſhed, though with ſome it fares otherwiſe in teeming women. Alſo that vehement deſire we call longing may well be ſuppoſed to produce great alterations in the body of the mother, which leaves ſuch ſtrange and laſting impreſſions upon that of the infant; ſince it is the mother only, and not at all the infant, that conceives thoſe importunate deſires.

The power of ſteams ſeen in the infectious effluvia.

Of alterations made by the paſſions of the mind.

CHAP. XIV.

THERE are many inſtances to be met with in phyſicians books, to ſhew, that imagination is able ſo to alter the imagining perſon's body, as to work ſuch a diſpoſition in the ſpirits, blood and humours of it, as to produce the determinate diſeaſe that is exceſſively feared. And I remember, that ſoon after the laſt fair lady *R.* died of the ſmall-pox, I chanced to meet one of her ſiſters, with her maſk on, amongſt ſome other perſons of high quality, and wondering to ſee her ſit maſk'd in ſuch company, her huſband (who was preſent) told me, that his wife having been happily brought to bed ſome while before her ſiſter fell ſick, he had carefully kept the knowledge of her ſickneſs from his wife; leſt the kindneſs, that was betwixt them two, might prejudice her in the condition ſhe was in: but that after a while, a lady unawares making mention in her hearing of her ſiſter's ſickneſs, ſhe immediately fancied, that ſhe ſhould have it too, and accordingly fell ſick of that diſfiguring diſeaſe, whoſe marks obliged her for a while to wear a maſk. Nor is it in women only, but even in men, that conceit may produce ſuch real and laſting effects. For many authentick hiſtories record examples of thoſe, in whom exceſſive grief or fear has made ſuch a change in the colour of their hair in a night, as nature would otherwiſe have ſcarce made in divers years. And I remember, that being about four or ſix years ſince, in the county of *Cork*, there was an Iriſh captain, a man of middle age and ſtature, who coming with ſome of his followers to render himſelf to your uncle *Broghill*, who then commanded the Engliſh forces in thoſe parts, upon a publick profer of pardon to the Iriſh, that would then lay down their arms, he was caſually, in a ſuſpicious place, met with by a party of the Engliſh, and intercepted. And my brother being then abſent upon a deſign, he was ſo apprehenſive of being put to death by the inferiour officers, before your uncle's return, that that anxiety of mind quickly changed the colour of his hair after a peculiar manner: of which I (being then at that caſtle of your uncle's, whereunto he was brought) had quickly notice given me, and had the curioſity to examine this captain, and found, that the hair of his head, had not (as in the inſtances I had met with in hiſtories) uniformly changed its colour, but that here and there certain peculiar tufts and locks of it, whoſe baſes might be about an inch in diameter, were thus ſuddenly turned white all over: the reſt of his hair (of which you know the Iriſh uſe to wear good ſtore) retaining its former reddiſh colour.

Divers inſtances of the power of imagination.

An inſtance of the hair of the head changed in colour upon a ſudden fear.

[You will miſtake my deſign, *Pyrophilus*, if you conclude from what I have ſaid, concerning the power of effluvia to work upon the body, that I am either ſo much an Helmontian, as to condemn the uſe of all thoſe remedies, that make ſuch more groſs evacuations

(if I may ſo call them) as are made by vomit, ſiege, and the like; or that I would have you, or am my ſelf ſo credulous, as to believe all the virtues, that are even by eminent writers aſcribed to the remedies called Specificks. For (to mention here but this) we have obſerved, that the hopes built upon even excellent ſpecificks, unleſs they be of ſuch a reſolving and abſterſive nature, as to be able to make way for themſelves into the receſſes of the body, are oftentimes diſappointed, where ſome emetick or cathartick remedy has not been firſt uſed to free the ſtomach and guts from thoſe viſcous humours, which obſtructing the firſt paſſages, much enervate the virtue of the remedy, if they do not altogether deny it acceſs to the innermoſt parts of the body. That then, which I aim at, is firſt to keep you from being prejudiced by the confidence of ſome learned doctors, who laugh at the very name of ſpecificks, and will not allow any diſeaſe to be curable, but by viſible evacuations of ſtore of what they call peccant matter; and next to give you cauſe to think, that ſuch ſpecificks, as men of judgment and credit do recommend upon their own experience, ought not to be rejected without trial, upon the bare account of their not being either laxative or vomitive, ſudorifick, or diuretical; nay, not ſo much as for this, that they are not endowed with any eminent degree of any manifeſt quality, ſuch as heat, cold, dryneſs, odour, taſte, aſtriction, and the like; nor able perchance to work any conſiderable alteration in a healthy human body. For I conſider the body of a living man, not as a rude heap of limbs and liquors, but as an engine conſiſting of ſeveral parts ſo ſet together, that there is a ſtrange and conſpiring communication betwixt them, by virtue whereof, a very weak and inconſiderable impreſſion of adventitious matter upon ſome one part may be able to work on ſome other diſtant part, or perhaps on the whole engine, a change far exceeding what the ſame adventitious body could do upon a body not ſo contrived. The faint motion of a man's little finger upon a ſmall piece of iron, that were no part of an engine, would produce no conſiderable effect; but when a muſket is ready to be ſhot off, then ſuch a motion being applied to the trigger by virtue of the contrivance of the engine, the ſpring is immediately let looſe, the cock falls down, and knocks the flint againſt the ſteel, opens the pan, ſtrikes fire upon the powder in it, which by the touch-hole fires the powder in the barrel, and that with great noiſe throws out the ponderous leaden-bullet, with violence enough to kill a man at ſeven or eight hundred foot diſtance. And that alſo the engine of an human body is ſo framed, as to be capable of receiving great alterations from ſeemingly ſlight impreſſions of outward objects, upon the bare account of its particular contrivance, may appear by ſeveral inſtances, beſide thoſe, which may belong to this argument in the foregoing part of this eſſay. When a man goes ſuddenly out into the ſun, it often happens, that thoſe beams, which light upon the head, and would not in ſo ſhort a time have any diſcernible effect on the leaſt hair of it, do almoſt in a moment produce that ſtrange and violent motion in the head, and almoſt all the body, which we call ſneezing. Men, that from the top of ſome pinnacle, or other high and ſteep place, do look down to the bottom of it, are at firſt very apt by the bare proſpect, (which yet conveys nothing into the body, but thoſe images, if yet there intervene corporeal ones in ſenſation of viſible objects, that enter the eye) to become ſo giddy, that they are reduced to turn away their eyes from the precipice, for fear of not being able to ſtand upon their legs. And many, that looked fixedly upon a whirlpool, or upon a very ſwift ſtream, have had ſuch a vertiginous motion thereby impreſſed on their ſpirits, that they have been unable to keep their bodies upright, but have fallen into the water they gazed on. And it is no leſs remarkable, that when a man is ſomewhat diſcompoſed at ſea, and yet not enough to vomit freely; the ſeamen are wont to adviſe him to look from the ſide of the ſhip upon the water, which ſeeming ſwiftly to paſs by the veſſel, has upon the gazer the operation of a rapid ſtream, and by making him giddy, haſtens and facilitates his vomiting; as I have ſometimes tried upon my ſelf, when I had a mind for health's ſake to be put into a fit of ſea-ſickneſs. If a perſon be very tickliſh, and you but gently ſtroke the ſole of his foot with the top of a feather, that languid impreſſion on the bottom of the foot ſhall, whether he will or no, put all thoſe muſcles and other parts into motion, which are requiſite to make that noiſe, and to exhibit that ſhape of the face (ſo far diſtant from the feet) which we call laughing; and ſo the gentle motion of a ſtraw, tickling the noſtrils, is able to excite ſneezing. Moſt men may obſerve in themſelves, that there are ſome ſuch noiſes, as thoſe made by the grating of an ungreaſed cart-wheel upon the axle-tree, or the tearing of coarſe paper, which are capable of ſetting the teeth on edge, which yet cannot be done without exciting a peculiar motion in ſeveral parts of the head. I had a ſervant, who ſometimes complained to me of a much more remarkable and unfrequent diſorder; namely, that when he was put to whet a knife, that ſtridulous motion of the air was wont to make his gums bleed. *Henricus ab Heer* (in his twenty ninth obſervation) records a ſtory of a lady, to whom he was ſent for, who upon the hearing of the ſound of a bell, or any loud noiſe, though ſinging, would fall into fits of ſounding, which was ſcarce diſtinguiſhable from death; and we may confirm, that this diſpoſition depended upon the texture of her body, in reference to material ſounds, by what he ſubjoins, that having well purged her, and giving her for two months the *Spaw*-waters, and other appropriate remedies, he thoroughly cured her. And it often enough happens, that when a woman is in a fit of the mother, another hyſterical perſon ſtanding by, is, by reaſon of a peculiar diſpoſition of her body, ſoon infected with the like ſtrange diſcompoſure. And to ſhew you, that a diſtempered body is both an engine, and alſo an engine diſpoſed to receive alterations

How the author's diſcourſe concerning the power of effluvia ought to be underſtood.

That the particular ſtate and diſpoſition of the engine of an human body is conſiderable as to the effects of theſe impreſſions.

from ſuch impreſſions as will make none on a ſound body, let me put you in mind, that thoſe ſubtile ſteams, that wander through the air before conſiderable changes of weather diſcloſe themſelves, are wont to be painfully felt by many ſickly perſons, and more conſtantly by men, that have had great bruiſes or wounds in the parts, that have been ſo hurt; though neither are healthy men at all incommodated thereby, nor do thoſe themſelves, that have been hurt, feel any thing in thoſe ſound parts, whoſe tone or texture has not been altered or enfeebled by outward violence. I have known ſeveral alſo (and the thing is obvious) whoſe bodies and humours are ſo framed and conſtituted, that if (as men commonly ſpeak) they ride backward in a coach, that motion will make them giddy, and force them to vomit. And it is very ordinary for hyſterical women to fall into ſuch fits as counterfeit epilepſies, convulſions, and I know not what violent diſtempers, by the bare ſmell of muſk and amber, and other ſtrong perfumes, whoſe ſteams are yet ſo far from having great, much leſs ſuch effects in other human bodies, that almoſt all men, and the generality even of healthy women, are not affected by them, unleſs with ſome innocent delight. And that even on men, odours (how minute and inviſible bodies ſoever) may ſometimes have very great power, may be gathered from the ſtory told us by *Zacutus Luſitanus*, of a fiſherman, who having ſpent all his life at ſea, and being grown old there, and coming to gaze upon a ſolemn reception made in a maritime town, to *Sebaſtian* king of *Portugal*, was, by the perfumes plentifully burnt, to welcome the king, immediately caſt upon the ground thereby into a fit, which two phyſicians judged apoplectical, and phyſicked him accordingly, till three days after the king's chief phyſician, *Thomas à Vega*, gueſſing at the cauſe of the diſeaſe, commanded him to be removed to the ſea-ſide, and covered with ſea-weeds, where, within four hours, the maritime air and ſteams began to open his eyes, and made him know thoſe, that were about him, and within not many days reſtored him to health. We may alſo conjecture, how much the alteration produced in the body by ſickneſs may diſpoſe it to receive ſtrong impreſſions from things, that would not otherwiſe much affect it, by this; that even a man in perfect health, and who is wont to drink cold without the leaſt harm, may, when he has much heated himſelf by exerciſe, be caſt by a draught of cold drink into ſuch ſudden, formidable and dangerous diſtempers, as, did not daily experience convince us, we ſhould ſcarce think poſſible to be produced in a body, free from morbid humours, by ſo familiar a thing as a cup of ſmall-beer or water: inſomuch that *Benivenius* relates a ſtory of one, who after too vehement exerciſe drinking a glaſs of very cold water fell into a ſwoon, that was quickly ſucceeded by death. And yet, to add that, on this occaſion, in bodies otherwiſe diſpoſed, a large draught of cold water, drunk even without thirſt, may very much relieve the drinker, and prevent great fits of the mother, and partly of the ſpleen, eſpecially upon ſudden frights; to which purpoſes, I know ſome hyſterical ladies, that find in this remedy, as themſelves aſſure me, more advantage, than one would eaſily imagine.

In Pr. med. adm. l. 3. Obſervat. 99.

AND (farther) to ſhew you, that the engine we are ſpeaking of, is alterable, as well for the better as for the worſe, by ſuch motions of outward bodies, as, in themſelves conſidered, are languid, or at leaſt may ſeem deſpicable in reference to ſickneſs or recovery; let me call upon you to conſider a few, not unobvious, things, which may alſo ſerve to confirm ſome part of what has hitherto been delivered.

The effects of the moſs growing on a human ſkull in ſtanching blood.

[THE true moſs growing upon a human ſkull, though I do not find experience warrant all the ſtrange things ſome chymical writers attribute to it for the ſtanching of blood, yet I deny not, but in ſome bodies it does it wonderful enough. And I very well know an eminent Virtuoſo, who has aſſured me, as his phyſician likewiſe has done, that he finds the effects of this moſs ſo conſiderable upon himſelf, that after having been let blood, his arm falling to bleed again, and he apprehending the conſequences of it, his phyſician, who chanced to be preſent, put a little of the abovementioned moſs into his hand; which, barely held there did, to the patient's wonder, ſtanch his blood, and gave him the curioſity to lay it out of his hand, to try, whether the moſs were the cauſe of the blood's ſo oddly ſtopping its courſe; whereupon his arm, after a little while, beginning to bleed afreſh, he took the moſs again into his hand, and thereby preſently ſtanch'd his bleeding the ſecond time: and, if I miſremember not, he added, that he repeated the experiment once more with the like ſucceſs. The ſmoke of burnt feathers, or tobacco blown upon the face of an hyſterical woman, does oftentimes almoſt as ſuddenly recover them out of fits of the mother, as the odour of perfumes did caſt them thereinto.]

Burnt feathers, or the ſmoke of tobacco removes hyſterical fits.

AND now I ſpeak of cures performable by fumes, it brings into my mind, that a friend of yours and mine, and a perſon of great veracity, profeſſes to have ſtrangely cured dyſenteries by a way uſual enough; which is to make the patient ſit over a chair or ſtool cloſe on the ſides, and perforated below, ſo that the *anus* and the neighbouring parts may be expoſed to the fumes of ginger, which muſt be thrown upon a pan of embers, placed juſt under the patient, who is to continue in that poſture, and to receive the fume, as long as he can endure it without too much fainting. And when I mentioned one of the cures, that was thus performed, to one, that is looked upon as a maſter of chymical arcana againſt diſeaſes; he preferred before it (as he ſays upon experience) the ſhavings of hartſhorn uſed after the ſame manner; and the remedy ſeems not irrational. But if in this diſtemper, the actual heat applied to the above-mentioned part of the body concur not to the effect, we may too, warrantably enough, add, that cures may be performed by far more minute corpuſcles than thoſe of ſmoke, inſinuating themſelves from without into the body. For I know a very dexterous goldſmith, who, when he over-

Cures of dyſenteries by fumes.

heats himſelf, as he often unawares does at hammering of plate, is ſubject to fall into gripings of the belly, which lead to fluxes; but his uſual and ready cure is, as ſoon as conveniently he can, to heat his anvil, and ſit upon it for a great while together, heating it hot again, if there be need. But to return to our medicinal ſmokes, it is known, that ſome find more good againſt the fits of the colick, by the clyſters of the ſmoke of tobacco, than by any other phyſick they take; ſo that I know wealthy perſons, that relying upon the benefit they find by this remedy, have left off ſending for their phyſicians to eaſe them of the colick. And indeed, when I conſider what an odd concrete even common ſoot is, and that many concretes, by being reſolved into ſmoke, may be either more or otherwiſe unlocked, than they would be by the ſtomach of a man, (ſo that I may elſewhere entertain you of the great heightening of ſome emetick and cathartick ſimples in their operation, by their being reduced into ſmoke) and that alſo probably the operation of ſome fumes and odours may be much changed and improved by their not getting into the body by the mouth, but other parts; I am inclinable to think, that there might be made further uſe of them, if phyſicians pleaſed, than hitherto has been. For I have made ſuch trial of the virtue of ſulphureous ſmoke, to preſerve ſome liquors, as I was much pleaſed with. And not only *Paracelſus*, but *Helmont* highly extols, as a grand ſpecifick in fits of the mother, the ſmoke of the warts, that grew upon the legs of horſes, conveyed to the parts ſuppoſed to be primarily affected. And I remember, that lately I met with a gentleman curious and intelligent, who, as himſelf aſſured me, was by the ſcurvy and ill-conditioned ulcers, and other obſtinate diſtempers, brought ſo low, that he was ſcarce able to turn himſelf freely in his bed, and thereupon reſolved againſt taking any more phyſick, partly out of deſpair of recovery, and partly of wearineſs of the tedious courſes of phyſick the doctors had in vain made him paſs through: but that ſome of his friends bringing him a certain ſurgeon, whom they affirmed to have ſtrangely cured many deſperate diſtempers, by ways very unuſual and not troubleſome to the patient, this gentleman was content to put himſelf into his hands; the ſurgeon promiſing, that he would not give him any other phyſick, but now and then a cup of ſack by way of cordial; his way of cure being to fumigate the patient very well every morning with a certain ſmoke, which that gentleman thinks, by what he took notice of, in the powder that yielded it, to have been ſome vegetable, ſubſtance. And with this remedy in a ſhort time he grew perfectly well, and came home a while ſince in very good health, from a voyage, which the confuſions of his own country invited him to make as far as the *Eaſt-Indies*. This ſurgeon, whoſe name I cannot hit upon, dying ſuddenly, his ſecret (which was tried upon divers others beſides this gentleman) is, for aught we know, dead with him.

And by ſitting on a hot anvil.

Cures of the colick by glyſters of the ſmoke of tobacco.

Of other cures done by ſmokes.

[But as for the efficacy, that may be found in appropriated fumes and ſteams, we have more than once, by barely unſtopping and holding under her noſe a ſmall phial of highly rectified ſpirit of ſal-armoniack, or even of hartſhorn, almoſt preſently recovered a young beauty, I need not name to you, out of ſtrange fits, that were wont to take her more ſuddenly than thoſe of the falling-ſickneſs, and were looked upon as epileptical, though perchance they were not merely ſo. To which I ſhall add, that a lady, that both you, *Pyrophilus*, and I know and love very well, though ſhe have been long ſubject to violent and tedious fits of the head-ach, and though that diſtemper hath been much increaſed by a great concuſſion of her head, occaſioned by the overturning of a coach, yet ſhe is wont preſently to be relieved, barely by holding her head a pretty while over a ſtrong decoction of tea, and breathing in the ſteams of it.]

And now I am diſcourſing of cures made by ſteams, or other ſeemingly ſlight means, I muſt not pretermit a thing ſo remarkable, that if it were more generally known in *Europe*, I ſhall think it ſomewhat ſtrange to find it ſo little reflected on by phyſicians; and that is, the conſtant and almoſt ſudden ceaſing of the plague, how raging ſoever, in the almoſt incredibly populous city of *Grand Cairo* in *Egypt* towards the latter end of *June*, about which time in moſt countries in our hemiſphere it is wont to ſpread faſteſt, and be moſt rife. The truth of this is atteſted by ſo many travellers of ſeveral nations, that it were injurious to doubt of it; and not only the dexterous Mr. *R.* whom you well know, and who lived at *Cairo*, has confirmed to me the truth of it, but the learned *Proſper Alpinus*, who both was an excellent phyſician, and ſpent many years in *Egypt*, gives us this particular account of it: *Peſtis Cayri atque in omnibus locis Ægypti invadere eos populos ſolet ineunte Septembri menſe, uſque ad Junium: his enim omnibus menſibus, à Septembri ad Junium uſque, peſtis aliunde per contagium illuc aſportata eam gentem invadere ſolet.* And after a few lines, *Junio verò menſe, qualiſcunque & quantacunque ſit ibi peſtilentia, ſole primam cancri partem ingrediente, omnino tollitur, quod multis planè divinum eſſe non immeritò videtur: ſed quo etiam valde mirabile creditur, omnia ſupellectilia peſtifero contagio infecta tunc nullum contagii effectum in eam gentem edunt; ita ut tunc ea vobis in tutiſſimo & tranquilliſſimo ſtatu reducatur ex ſummè morboſo: atque morbi particulares, ſporadici à Græcis vocati, tunc apparere incipiunt, qui nuſquam gentium tempore peſtis apparebant.* 'The plague at *Grand Cairo*, 'and in all parts of *Ægypt*, is wont to invade 'the inhabitants from the beginning of the 'month *September* until *June*: for in all theſe 'months, from *September* unto *June*, the plague 'from other nations is brought thither, and is 'wont to infect that nation. But in the month 'of *June*, of what nature and how great ſoever 'the peſtilence be, when the ſun firſt enters *Cancer*, it is immediately removed; which thing 'many (and that not without reaſon) take to 'be a particular mercy of God. But (what 'is more admirable) all houſhold-ſtuff, however infected with the contagion of the diſ-

Of the ſudden ceaſing of the plague at Grand Cairo in June.

De medicina Ægyptiorum. lib. 1. cap. 17.

'eaſe,

'eaſe, at that time ſhews no effect of any contagion, ſo that then the whole nation paſſes 'into a moſt ſecure and healthy condition, 'from a morbid and dangerous; and then 'thoſe diſeaſes, which are called by the Greeks '*Sporadici*, begin to appear, which in no part 'of the world are ſeen to be rife together with 'the plague.' And in the next chapter, inquiring at large into the cauſes of this wonder, he denies it to proceed from the increaſe of the *Nile*, which happens to be coincident in point of time with the extinction of the plague, becauſe that the infection ceaſeth before the ſwelling of the river is conſiderable; and aſcribeth it rather to the alteration of the air, produced by the northerly winds, which then begin to blow, and ſome other circumſtances: ſpeaking of which, *Hæc* (ſaith he) *per id temporis incipiunt obſervari, à quibus fortaſſe non immeritò cauſam extinctionis peſtis morboſique in ſalubrem ſtatum mutationis pendere arbitror: quando nulla alia ex conſervatricibus cauſis, quas vulgus medicorum res non naturales appellat, aëre excepto, ibi eo tempore appareat, in quam morboſi ſtatus in ſalubrem mutationem referre poſſumus: ideo neceſſarium erit hujuſce mutationis cauſam aëris mutationi acceptam referre, &c.* *Ibidem, c. 18.*

'Theſe things are firſt obſerved about that 'time. From which, I think, and perchance 'not without reaſon, the cauſe of the extinction 'of the plague, and the change of the ſtate 'from morbid to wholeſome doth depend; 'for no other of the conſervative cauſes, which 'are wont to be called by phyſicians *res non-naturales*, appeareth then, beſides the air: to 'which we may refer this change from diſeaſe 'to healthineſs; and therefore we muſt refer 'this change to the change of the air.' Upon this inſtance, *Pyrophilus*, I have preſumed the longer to inſiſt, becauſe (if you duly reflect on it) you will, I ſuppoſe, diſcern, that it much credits and elucidates a great part of what hath been delivered in divers of the foregoing leaves, concerning the poſſibility of nature's doing great matters againſt diſeaſes, without the help of groſs and ſenſible evacuations.

CHAP. XV.

That human body may be altered by ſuch motions, as act in a groſs and meerly mechanical manner, proved by divers inſtances.

AND ſince we have repreſented a human body as an engine, we ſhall add, that it may be altered both for the better and for the worſe, by ſuch bare motions or impulſes of external bodies, as act but in a groſs and confeſſedly mechanical manner. For it is known, that out of ſuch ſpeedily killing (unleſs ſeaſonably remedied) diſtempers, as fits of ſwooning, patients of either ſex are often recovered without any inward medicine, by being barely pinched in ſeveral places. I, that have endured great and dangerous ſickneſſes, have ſcarce ever found any ſo violent for the time, as that, which the bare motion and ſmell of a ſhip and ſea-air hath put me into, eſpecially in rough weather, till I was ſomewhat accuſtomed to navigation; and yet this violent and weakning ſickneſs, as it was not produced by a peccant humour in the body, ſo it was quickly removed by the air, and quiet of the ſhore, without the help of phyſick. And the like may be obſerved more ſuddenly in the newly mentioned inſtances of thoſe, in whom the bare agitation of a coach will produce ſuch violent fits of vomiting, and ſuch faintneſs, that I have known ſome of them apprehend they ſhould preſently die; ſo the bare ceſſation of that diſcompoſing motion ſoon relieved them. We ſee in our ſtables, what operation the currying of them carefully hath upon our horſes. And *Helmont* ſomewhere tells us, that himſelf, as I remember, could, by the milk of an aſs, tell, whether ſhe had been that day diligently curried or no; and ſo conſiderable an alteration in milk ſhould methinks ſtrongly argue, that a great one is in the blood or other juice, of which the blood is elaborated, and conſequently in divers of the principal parts of the body muſt have preceded it. But to prefer our conſideration from the bodies of beaſts to thoſe of men, it is remarkable what *Piſo* confeſſeth, the illiterate Braſilian empiricks are able to perform with frictions, even as unſkilfully as they order them: *Mira equidem, tum tuendæ ſanitatis ergo, cum in pleriſque morbis ſanandis, frictione & unctione frequenti incolæ præſtant, illam frigidioribus, & chronicis, hanc in acutioribus adhibentes. Quæ remedia lubenter advenæ imitantur, &, ut par eſt, ex legibus artis hæc & plura medendi empiricorum genera moderantur.* *Hiſtor. Nat. Med.* lib. 2. cap. 5. p. 33.

'The inhabitants do 'ſtrange things, both in preſerving health and 'in curing diſeaſes, by friction and unction, 'uſing the firſt in cold and chronical, the latter in acute diſeaſes. And ſtrangers, who 'arrive there, are, as they ought, willing to 'imitate their ways of phyſick, and by rules of 'art to preſide and moderate theſe ways of 'empirical healing.' And as *Galen* himſelf highly extols a ſkilfull application of cupping-glaſſes in the colick; ſo *in Braſil* they find, that the like remedy is ſtrangely ſucceſsful: for *Cholera ſicca*, ſaith our candid *Piſo* in another place, *eiſdem ferè remediis* (of which he had been ſpeaking) *curatur, maximè ſi regioni hepatis corneæ cucurbitulæ applicentur. De quibus merito hoc teſtor, quod Galenus de ſuis cucurbitulis, quas in colico affectu incantamenti inſtar operari tradidit.* *Idem* cap. 11.

'*Cholera ſicca* is cured by the ſame remedies, 'eſpecially if their horny cupping-glaſs be ap'plied to the region of the liver, of which I 'muſt atteſt the ſame thing, that *Galen* doth 'of cupping-glaſſes; which he affirmed to 'work as miraculouſly, as if their operation 'had depended on enchantment.'

WE ſhall add, for further confirmation, that notwithſtanding all the horrid ſymptoms, that are wont to enſue upon the biting of that poiſonous ſpider, the *Tarantula*, that laſting and formidable diſeaſe, which often mocks all other remedies, is by nothing ſo ſucceſsfully oppoſed, as by muſick; ſome determinate tune or other, which proves ſuitable to the particular nature of the patient's body, or that of the poiſon producing there ſuch a motion, or determination of ſome former motion of the ſpirits, or the humours, or both, as by conducting the ſpirits into the nerves and muſcles inſervient to the motion of the limbs, doth make the patient leap and dance, till he have put himſelf into a ſweat, that breathes out much of the virulent

The inſtances of the cure of the Tarantula by muſick particularly modified.

virulent matter, which hath been probably fitted for expulſion, by ſome change wrought in its texture or motion, or thoſe of the blood, by the muſick. For if ſweat and exerciſe, as ſuch, were all that relieved him, why might not ſudorificks, or leaping without muſick, excuſe the need of fidlers? which yet is ſo great, that *Kircher* informs us, that the Apuleian magiſtrates are wont to give ſtipends, at their publick charge, to ſuch, to relieve the poor by their playing. And not only he hath the memorable ſtory of *Robertus Pantarus*, a Tarantine nobleman, whoſe diſeaſe being not known to proceed from the biting of a ſpider, could by no remedies be cured; he was at length, even upon the point of death, ſuddenly relieved, and by degrees reſtored to perfect health by the uſe of muſick: but *Epiphanius Ferdinandus*, in his accurate obſervations concerning thoſe bitten with the tarantula, together with *Mathiolus*, and other authors, bear witneſs thereunto by reſembling narratives. Now that a ſound (not barely as a ſound, but ſo modified) may powerfully operate upon the blood and ſpirits, I, who am very muſically given, have divers times obſerved in myſelf, upon the hearing of certain notes. And it might be made probable, both by that, which we have formerly ſaid of the effect of ſkreaking upon the teeth and gums, and by the dancing fit, into which not every muſical ſound, though never ſo loud, but ſome determinate tune is wont to put the bitten patient. But it may be more manifeſtly proved, by the following teſtimony of our inquiſitive Jeſuit, wherein he affirms, that the ſpiders may, as well as thoſe they have bitten, be made to dance by tunes ſuited to their peculiar conſtitutions. *

Muſurg. lib. 9. cap. 4.

AND this I the leſs wonder at, becauſe *Epiphanius Ferdinandus* himſelf not only tells us of a man of 94 years of age, and ſo weak, that he could not go, unleſs ſupported by his ſtaff, who did, upon the hearing of muſick after he was bitten, immediately fall a dancing and capering like a kid; and affirms, that Tarantula's themſelves may be brought to leap and dance at the ſound of lutes, ſmall drums, bagpipes, fiddles, *&c.* but challenges thoſe, that believe them not, to come and try, promiſing them an ocular conviction: and adds, what is very memorable and pleaſant, that not only men, in whom much may be aſcribed to fancy, but other animals being bitten, may likewiſe, by muſick, be reduced to leap or dance: for he ſaith, he ſaw a waſp, which being bitten by a Tarantula whilſt a lutaniſt chanced to be by; the muſician playing on his inſtrument, gave them the ſport of ſeeing both the waſp and ſpider begin to dance: annexing, that a bitten cock did the like.

CHAP. XVI.

Divers inſtances of the ἰδιοσυγκρασίαι, *or peculiar averſion of particular perſons from particular things, and of the commotions made in the body thereby.*

I MIGHT alſo, *Pyrophilus*, confirm what I told you, when I ſaid, that ſickneſs may produce ſuch an alteration in the fabrick of the body, as to make it capable to be very much affected, as well for the better as for the worſe, by ſuch things, that would not ſcarce at all effect it if it were ſound, from the conſideration of thoſe many and ſtrange ἰδιοσυγκρασίαι, or peculiarities, to be met with in ſome perſons in ſickneſs and inhealth. For though many of theſe differences between healthy men are not likely to be greater, than may be obſerved between the ſame man, when well, and himſelf as the oeconomy of his body may be diſcompoſed by ſome diſtemper; yet we often ſee, that ſome perſons have the engine of their body ſo framed, that it is wonderfully diſordered by ſuch things, as either work not at all on others, or work otherwiſe on them; as it is common enough for men to be hugely diſturbed, and ſome of them to fall into fits of trembling and ſwooning, upon the ſight or hearing of a cat. And to ſuch an affection I know a very eminent commander obnoxious, your late unkle, the laſt Earl of *Barrymore*, a very gallant nobleman, and who did his country great ſervice in the Iriſh wars, had the like apprehenſion for tanſey. I cannot ſee a ſpider near me, without feeling a notable commotion in my blood, though I never received harm from that ſort of creature, and have no ſuch abhorring againſt vipers, toads, or other venomous animals. You know an excellent lady (married to a great perſon, that hath more than once governed *Ireland*) whoſe antipathy to honey, which is much talked of in that country, hath diſplayed it ſelf upon ſeveral occaſions; notwithſtanding which, her experienced phyſician imagining, that there might be ſomething of deceit in her averſion, took an opportunity to ſatisfy himſelf, by mixing a little honey with other ingredients of a remedy which, he applied to a very ſlight and inconſiderable cut or ſcratch, which ſhe chanced to get on her foot; but he ſoon repented of his curioſity, upon the ſtrange and unexpected diſorder, which ceaſing upon the removal of that, and application of other ordinary remedies, ſatisfied him, that thoſe ſymptoms were to be imputed to the honey, and not the bare hurt. The ſame excellent lady, I remember, complained to me, that when ſhe was troubled with coughs, all the vulgar pectoral and pulmonick remedies did her no good, ſo that ſhe could find relief in nothing but either the fume of powdred amber, taken with convenient herbs in a pipe, or that *Balſamum ſulphuris*, which we have already taught you in this eſſay.

[I KNOW a perſon of quality, tall and ſtrong made,

* *Ubi ſonatores, qui muſica ſua hoc malum etiam publicis magiſtratus ſtipendiis ad pauperum remedium ſolatiumque conducti curare conſueverunt, ad curas patientium certius facilinſque accelerandas; primo ex infectis quærere ſolent ubi, quo loco, aut tempo, aut cujus coloris Tarantula erat, a quo morſus ipſis ſit inflictus. Quo facto indicatum locum protinus, ubi frequentes numero atque omnis generis Tarantulæ retium texendorum laboribus incumbunt, accedere ſolent medici citharœdi, variaque tentare harmoniarum genera: ad quæ (mirum dictu) nunc has nunc illas ſaltare non ſecus ac duorum polychordorum æqualiter concinnatorum, perſonatione illæ chordæ, quæ ſimiles ſibi fuerint tono, & æqualiter tenſæ moventur, reliquis immotis, ita ut pro ſimilitudine & conditione Tarantularum, nunc has nunc illas ſaltare comperiunt. Cum verò ejus coloris Tarantulam, quæ à patiente indicata fuerit, in ſaltum prorumpere viderint, pro certiſſimo ſigno habent, modulum ſe habere verum & certum, humori veneno τῷ ταραντίζοντος proportionatum, & ad curandum aptiſſimum, quo ſi utantur, infallibilem curæ effectum ſe conſequi aſſueverunt.* Kircher. Muſurg. lib. 9. part. 2. cap. 4.

made, who lately aſked my opinion, whether, when he had need of a vomit, he ſhould continue to make uſe of coffee, in regard it wrought ſo violently with him: this gave me the occaſion, as well as curioſity, of inquiring particularly both of himſelf and his lady, concerning this odd operation of coffee upon him; and I was told, that an ordinary wine-glaſs full of the uſual warm decoction of coffee boiled in common water, was wont, within about two hours, to prove emetick with him, and before noon did give him eight, ten, or ſometimes twelve vomits, with ſo much violence, that he was leſs affected by the infuſion of *Crocus metallorum*, or other uſual emeticks, and therefore was deliberating, whether he ſhould not change coffee for ſome of them, though finding its operation very certain, he had for ſome years accuſtomed himſelf to take that vomit. And that, which is alſo remarkable in this matter, is, that he tells me, that ſcarce any vomit is more troubleſome to him to take, than that above mentioned is grown of late, ſo that even the odour of coffee, as he paſſeth by coffee-houſes in the ſtreet, doth make him ſick; and yet that ſimple is to moſt men ſo far from being vomitive, that it is by eminent phyſicians, and in ſome caſes not without cauſe, much extolled as a ſtrengthener of the ſtomach. And this very gentleman himſelf uſed it a pretty while againſt the fumes, that offended his head, without finding any vomitive quality at all in it.]

THE books of ſober and learned phyſicians afford us examples of divers ſuch, and of much more ſtrange peculiarities, and likewiſe of ſuch perſons, who having deſires of certain things very extravagant, and even abſurd, (ordinarily not only improper, but hurtful to their diſtempers) have been cured by the uſe of them, of very dangerous and ſometimes hopeleſs diſeaſes: of which kind of cures I may alſo elſewhere tell you what I have obſerved, and ſome credit may be brought to ſuch relations, by what we ordinarily ſee more greedily devoured (without much harm) by longing women, and maids troubled with the green-ſickneſs.

That ſince the body receives ſuch alterations from ſuch unlikely things, there is no juſt arguing againſt ſpecificks, becauſe they operate not by any obvious qualities.

BUT now, *Pyrophilus*, ſince the engine of an human body thus appears to be ſo framed, that it is capable of receiving great alterations from ſuch unlikely things as thoſe we have been mentioning; why ſhould we haſtily conclude againſt the efficacy of ſpecificks, taken into the body, upon the bare account of their not operating by any obvious quality, if they be recommended unto us upon their own experience by ſober and faithful perſons? and that ſcarce ſenſible quantities of matter, having once obtained acceſs to the maſs of blood (which is very eaſily done by the circulation) may, by the contrary and ſwift motion, and by the figure of the corpuſcles it conſiſts of, give ſuch a new and unnatural impediment or determination to the motion of the blood, as to diſcompoſe either its texture, or that of the heart, brain, liver, ſpleen, or ſome ſuch principal part of the body, (as a ſpark of fire reduceth a whole barrel of gunpowder, to obey the laws of its motion, and become fire too; or as a little leaven is able, by degrees, to turn the greateſt lump of dow into leaven) need be manifeſted by nothing, but the operations of ſuch poiſons, as work not by any of thoſe (which phyſicians are pleaſed to call) *Manifeſt Qualities*. For though I much fear, that moſt of thoſe, that have written concerning poiſons, ſuppoſing that men would rather believe than try what they relate, have allowed themſelves to deliver many things more ſtrange than true; yet the known effects of a very ſmall quantity of opium, or of arſenick, of the ſcarce diſcernable hurt made by a viper's tooth, and eſpecially of the biting of a mad dog, (which ſometimes, by leſs of his ſpittle than would weigh half a grain, ſubdues a whole great ox into the like madneſs, and produceth truly wonderful ſymptoms both in mens bodies and beaſts) are ſufficient to evince what we propoſed.

AND that man's body may be as well ſometimes cured, as we ſee it too often diſcompoſed, by ſuch little proportions of matter, may (not now to mention the queſtionable virtues aſcribed to many antidotes) be gathered from that experiment, ſo common in *Italy* and elſewhere, of curing the invenomed biting of ſcorpions, by anointing the bitten and tumid place with common oil, wherein ſtore of ſcorpions have been drowned and ſteeped. And a reſembling example of the antidotal virtue, wherewith nature hath enriched ſome bodies, is given us by the above commended *Piſo*, in his *Medicina Braſilienſis*, where (treating of the antidotal efficacy of the famous Braſilian herb *Nhanby*, eaten upon an empty ſtomach) he adds this memorable ſtory; That he himſelf ſaw a Braſilian, who having caught an over-grown toad, and ſwelled with poiſon (ſuch a one as Braſilians call *Cururu*) which uſeth to be as big again as the European toad, and deſperately venomous (which perhaps our toads are not) he preſently killed him, by dropping on his back the juice of the flowers and leaves of that admirable plant. And you may remember, that the ſame author formerly told us, in effect, that as great and ſalutary changes may be produced even in human bodies, where he relates, that he had known thoſe, that had eaten ſeveral ſorts of poiſon, ſnatched in a trice from imminent death, by only drinking ſome of the infuſion of the root he calls *Jaborandi*; and this, after I know not how many alexipharmaca and theriacal antidotes had been fruitleſly adminiſtred.

YOU will perchance tell me, *Pyrophilus*, that theſe three or four laſt inſtances are of poiſonous diſtempers and their antidotes; not of ordinary diſeaſes, and their ſpecifick remedies. But to this I have a double anſwer: and firſt, many of thoſe diſtempers, that proceed from poiſon, are really diſeaſes, and both called by that name, and treated of as ſuch, by phyſicians. And indeed they may well look upon them but as diſeaſes, exaſperated by a virulent malignity, which yet appears to be not always eaſily diſtinguiſhable from that of diſeaſes, that proceed not from poiſon, by this, that otherwiſe the phyſicians of princes and great men, if, after having

conſidered

conſidered all the inward parts of their diſ-bowelled patients, could not ſo often doubt and diſpute, as they do, whether or no poiſon were acceſſary to their death. And *Piſo* (who learnt divers of their deteſtable ſecrets from the Braſilians) relates, That ſome of them are ſo ſkilful in the curſed art of tempering and allaying their poiſons, that they will often hinder them from diſcloſing their deleterial nature for ſo long a time, that the ſubtile murderers do, as unſuſpectedly as fatally, execute their malice or revenge. Theſe diſeaſes indeed are wont to differ in this from ſurfeits, and other reſembling ordinary diſeaſes; that in the one, the venomous matter, that produceth the diſeaſe, is at firſt much more ſmall, than in the other the morbifick matter is wont to be. But the activity of this little quantity of hoſtile matter doth make it pernicious; that the diſorders it produceth in the body, being much greater than that of ordinary ſickneſſes is, the cure of ſuch diſtempers is the fitter to manifeſt how powerfully nature may be ſuccoured by remedies, that work not by firſt or ſecond qualities, ſince ſuch are able to deliver her from diſeaſes heightned by a peculiar and venomous malignity.

To this firſt I ſhall ſubjoin my next, which is, That divers paſſages of the former diſcourſe (eſpecially what we have related concerning the cure of agues, of the rickets, and of the king's-evil) may ſatisfy you, that even of ordinary diſeaſes (ſome at leaſt) may be as well cured by ſpecificks, as thoſe produced by poiſon are by antidotes.

You may alſo ſay, *Pyrophilus*, 'But what 'if a recommended ſpecifick do not only ſeem 'unable to produce the promiſed effect, but have 'qualities, which according to our notions of 'the nature of the diſeaſe, ſeem likely to conſpire 'with it and increaſe it?'

I anſwer,

What is to be done, when the ſpecifick ſeems likely to increaſe the diſeaſe.

FIRST, That though it is better for the patient to be cured by a raſhly and unſkilfully given medicine, than to die under the uſe of the moſt ſkilfully adminiſtred phyſick; yet that the phyſician, who loſeth his patient, after having done all, that his art preſcribed to ſave him, deſerves more commendation than he, that luckily chanceth to cure his patient by an irrational courſe. And therefore in ſuch a caſe as you put, *Pyrophilus*, I think the phyſician ought to be very well ſatisfied, as to the matter of fact, before he venture to try ſuch a remedy; eſpecially if more ordinary and unſuſpected means have not been imployed and found ineffectual: for it is not one lucky cure, that ought to recommend to a wary phyſician the uſe of a remedy, whoſe dangerous quality ſeems obvious, whereas its virtue muſt be credited upon report.

BUT then, ſecondly, If the phyſician be duly ſatisfied of the efficacy of the remedy, upon a competent number and variety of patients, I ſuppoſe he may, without raſhneſs, make uſe of ſuch remedies, at leaſt where ordinary medicines have been already fruitleſly tried.

CHAP. XVIII.

THAT you may ceaſe to wonder at my daring to ſay this, *Pyrophilus*, I muſt offer to you three or four particulars.

A diſquiſition concerning the ordinary method of phyſick.

AND firſt, it is manifeſt to thoſe that are inquiſitive, that the true nature and cauſes of ſeveral diſeaſes are much leſs certain, and much more diſputed of amongſt the doctors themſelves, than thoſe that are not inquiſitive imagine: nor is the method of curing divers particular diſeaſes more ſettled and agreed on, that depending chiefly upon the knowledge of thoſe cauſes, which, as I was ſaying, are controverted. It is not, that I am either an enemy to method in phyſick, or an undervaluer of it; but I fear the generality of phyſicians (for I intend not, nor need all along this eſſay ſpeak of them all) have as yet but an imperfect method, and have by the narrow principles they were taught in the ſchools, been perſuaded to change their method rather to the barren principles of the Peripatetick ſchool, than to the full amplitude of nature. Nor do I find, that phyſicians have yet done ſo fit a thing, as ſeriouſly (and with the attention, which the importance of the thing deſerves) on the one ſide, to enumerate and diſtinguiſh the ſeveral cauſes, that may any whit probably be aſſigned, how the phænomena of that diſordered ſtate of the human body, which we call a diſeaſe, or its ſymptoms, may be produced; and on the other ſide, by how many and how differing ways the phænomena may be removed, or the diſeaſes they belong to deſtroyed: and if this were analytically and carefully done, I little doubt, but that men's knowledge of the nature and cauſes of diſeaſes, and the ways of curing them, would be leſs circumſcribed, and more effectual than now it is wont to be. And I am apt to think, that even methodiſts would then find, that there are divers probable, if not promiſing methods (proper to divers caſes) which ways they yet overlook. And though in a right ſenſe it be true, that the phyſician is but nature's miniſter, and is to comply with her, who aims always at the beſt; yet if we take them in the ſenſe thoſe expreſſions are vulgarly uſed in, I may elſewhere acquaint you with my exceptions at them, and in the mean time confeſs to you, that I know not whether they have not done harm, and hindered the advancement of phyſick, faſcinating the minds of men, and keeping them from thoſe effectual courſes, whereby they may potently alter the engine of the body; and by rectifying the motion and texture of its parts, both conſiſtent and fluid, may bring nature to their bent, and accuſtom her to ſuch convenient courſes of the blood and other juices, and ſuch fit times and ways of evacuating (what is noxious or ſuperfluous, *&c.*) as may prevent or cure divers ſtubborn diſeaſes, more happily than the vulgar methodiſts are wont to do.

AND indeed, it is ſcarce to be expected, that till men have a better knowledge of the principles of natural philoſophy, without which it is hard to arrive at a more comprehenſive theory of the various poſſible cauſes or diſeaſes, and of the contrivance and uſes of the parts of the body, the method which ſuppoſes this knowledge ſhould be other than in many things defective, and in ſome erroneous; as I am apt to think, the vulgar method may be ſhewn to be, as to ſome particular diſeaſes.

Of

Of this I may perhaps elſewhere acquaint you more particularly with my ſuſpicions, and therefore I ſhall now only mention the laſt obſervation of this kind I met with, which was a gentleman, you and I very well know, who being for ſome months much troubled with a difficulty of breathing, and having been unſucceſsfully treated for it by very eminent phyſicians, we at laſt ſuſpected, that it was not the lungs, but the nerves, that ſerved to move the diaphragm and other organs of reſpiration, upon whoſe diſtemper this ſuppoſed aſthma depended; and accordingly, by a taking or two of a volatile ſalt of ours, which is very friendly to the *Genus nervoſum*, he was quickly freed from his troubleſome diſtemper, which afterwards he was fully perſuaded did not proceed from any ſtuffing up of the lungs. To be ſhort, how much eſteem ſoever we have for method, yet ſince that it ſelf and the theories whereon men ground it, are, as to divers particular diſeaſes, ſo hotly diſputed of, even among eminent phyſicians, that in many caſes a man may diſcern more probability of the ſucceſs of the remedy, than of the truth of the received notion of the diſeaſe; in ſuch abſtruſe caſes methinks it were not amiſs to reflect upon that reaſoning of the ancient empiricks (though on a ſomewhat differing occaſion) which is thus ſomewhere expreſſed by *Celſus: Neque ſe dicere conſilio medicum non egere, & irrationabile animal hanc artem poſſe præſtare, ſed has latentium rerum conjecturas ad rem non pertinere; quia non interſit, quid morbum faciat, ſed quid tollat.* 'Nor doth he ſay, that a phyſician 'needs nothing of counſel or deliberation, or 'that an irrational man may profeſs this art; 'but that thoſe conjectures of hidden things 'are nothing to the purpoſe. Becauſe it mat- 'ters not what cauſeth the diſeaſe, but what 'removes it.' And as the controverted method in the above mentioned diſeaſes is not yet eſtabliſhed or agreed on in the ſchools themſelves, ſo divers of thoſe, that are wholly ſtrangers to thoſe ſchools, do yet, by the help of experience and good ſpecificks, and the method their mother-wit does, according to emergencies, prompt them to take, perform ſuch conſiderable cures, that *Piſo* ſticks not to give this teſtimony to the utterly unlearned Braſilian empiricks: *Interim*, ſays he, *ſeniores & exercitatiores eximii ſunt botanici, facilique negotio omnis generis medicamina ex undiquaque in ſylvis conquiſitis conficiunt. Quæ tanta ſagacitate interne & externe illos adhibere videas, præcipue in morbis è veneno natis, ut quis illorum manibus tutius & ſecurius ſe tradat, quam medicaſtris noſtris ſciolis, qui ſecreta quædam in umbra nata atque educata crepant perpetuo, & ob has rationales dici volunt.* 'In the mean time, the 'Braſilian botaniſts make all ſorts of medi- 'cines of ſimples they find every where in the 'woods: which they make with ſo great ſaga- 'city, and apply them both internally and ex- 'ternally, eſpecially to diſeaſes that ſpring from 'venom, that a man may more ſecurely give 'himſelf over to their hands, than to our un- 'ſkilfull phyſicians, who brag much of ſecrets 'they have learnt in private, and for the know- 'ledge of theſe will be called rationals in phy- 'ſick.'

Hiſt. Nat. & Med. lib. 2. pag. 23.

SECONDLY, There are divers medicines, which, though they want not ſome one quality or other, proper to increaſe the diſeaſe, againſt which they are adminiſtred, are yet confidently uſed by the moſt judicious doctors, becauſe that they are ſo inriched with other qualities, whereby they may do much more good than their noxious qualities can do harm: as in a malignant feaver, though the diſtemper be hot, and though treacle and ſome other antidotal ſudorificks be hot alſo, yet they are uſefully adminiſtred in ſuch diſeaſes, becauſe the relief they bring the patient, by oppugning the malignity of the peccant matter, and perhaps by eaſing him of ſome of it by ſweat, is more conſiderable than the harm they can do him, by increaſing for a while his heat.

Inſtances of ſome medicines which are condemned for noxious, and yet have proved uſeful.

THE very experienced *Bontius*, chief phyſician to the *Dutch* plantation in the *Eaſt-Indies*, in his *Methodus medendi Indica*, treating of the ſpaſmus, which (though here unfrequent) he reckons among the endemical diſeaſes of the *Indies*, commends the uſe of *Quercetanus*'s laudanum, of philonium, and principally of an extract of opium and ſaffron, which he deſcribes and much extols: and leſt his readers ſhould ſcruple at ſo ſtrange a preſcription, he adds this memorable paſſage to our preſent purpoſe: *Fortaſſis* (ſays he) *ſciolus quiſpiam negabit his remediis, propter vim ſtupefactivam ac narcoticam nerviſque inimicam, eſſe utendum. Specioſa quidem hæc prima fronte videntur, ſed tamen vana ſunt. Nam præterquam quod calidiſſima hujus climatis temperies requirat, certiſſimum eſt in tali neceſſitate, ſine his ægrum evadere non poſſe. Adde, quod nos tam ritè opium hic præparamus, ut vel infanti innoxiè detur: & ſanè (ut verbo abſolvam) ſi opiata hic nobis deeſſent in morbis calidis his graſſantibus fruſtra remedia adhiberemus, quod etſi imperitis durum, ex progreſſu tamen me nil temerè dixiſſe patebit.* 'Perchance 'ſome ſcioliſt in phyſick may affirm, that theſe 'things may not be uſed, by reaſon of the 'narcotick and ſtupefactive property. But 'theſe pretences are as vain in effect as ſpecious 'at firſt ſight: for beſides that the hot temper 'of this country requires it, it is ſure, that 'without theſe remedies there can be no cure. 'Add, that here we prepare opium ſo well, that 'you may give it to an infant. And truly, 'if in hot diſeaſes we had no opiates, we ſhould 'in effect find, that the uſe of all other medi- 'caments would prove altogether vain and 'fruitleſs.'

Cap. 2.

THE drinking freely, eſpecially if the drink be cold water, is uſually (and in moſt caſes, nor without much reaſon,) ſtrictly forbidden, as very hurtful for the dropſy; and yet thoſe, that frequent the *Spaw*, tell us of great cures performed by pouring in plenty of waters into the patient's already diſtended belly. And I know a perſon of great quality and virtue, who being by an obſtinate dropſy, beſides a complication of other formidable diſeaſes, brought to a deſperate condition, was adviſed to drink *Tunbridge*-waters, when I happened to be there, by her very ſkilful phyſician; who told

told me, that the doctors having done all their art could direct them unto, in vain, ſhe would be cured by death, if ſhe were not by theſe waters; from whence (the weather proving very ſeaſonable for that ſort of phyſick) ſhe returned in ſo proſperous a condition of recovery, as exacted both his and my wonder. That the decoction of ſo heating a ſimple as guaiacum would be looked upon by the generality of phyſicians, both Galeniſts and Chymiſts, as a dangerous medicine in phthiſical and other conſumptions, you will eaſily grant: and yet ſome eminent phyſicians, and (particularly Spaniards) tell us of wonderful cures they have performed in deſperate ulcers of the lungs, by the long uſe of this decoction, notwithſtanding its manifeſtly and troubleſomely heating quality. And I know a phyſician eminently learned, and much more a methodiſt than a chymiſt, who aſſures me, that he has made trial of this unlikely way of curing conſumptions with a ſucceſs, that has much recommended theſe paradoxical Spaniards to him. It is alſo believed, and not without cauſe, by phyſicians, that mercury is wont to prove a great enemy to the *genus nervoſum*, and often produces palſeys, and other diſtempers of the brain in the nerves: and yet one of the exacteſt and happieſt methodiſts I know, has confeſt to me, that mercurial preparations are thoſe, which he uſes the moſt ſucceſsfully in paralytical and the like diſtempers of, what phyſicians call, the *genus nervoſum*. And on this occaſion I remember, that a gentlewoman being confined to her bed by a dead-palſey, that had ſeized on one ſide of her body, a phyſician eminent for his books and cures, giving her a doſe of a certain preparation of mercury, corrected with a little gold, which I put into his hands for that purpoſe, was pleaſed to bring me word, that by the firſt taking of the powder, which wrought but gently by ſiege, without either vomits or ſalivation, ſhe was enabled the ſame or the next day to quit her bed, and walk about the room.

Of the uſe of guaiacum for conſumptions, and mercury for palſies.

THIRDLY, there are many things, which ſeem to be againſt reaſon, whilſt they are barely propoſed and not proved, for which we afterwards diſcern very good reaſon; when experience having ſatisfied us they are really true, has both invited us, and aſſiſted us, to inquire into their cauſes. Of this we have elſewhere given divers not medical inſtances in our eſſay *concerning improbable truths*: and I could eaſily enough, if I durſt be tedious, give you ſome medical illuſtrations of the ſame truth. But I dare now only invite you to conſider this one thing, which may be of great uſe to explicate many others, both in natural philoſophy, and in phyſick too; which is, that there are divers concretes, ſome of them, as to ſenſe, ſimilar, or homogeneous, whoſe differing parts are endowed with very differing and ſometimes contrary qualities. And this not only appears in the chymical analyſis of bodies made by the fire, where the difference of what chymiſts call the ſeparated principles of concretes, is often very manifeſt and great, but even in divers bodies, that have not been reſolved by the violence of the fire; as is evident in rhubarb taken in ſubſtance, whoſe ſubtiler parts are purging, and its terreſtrial aſtringent. Nay, if thoſe parts, which do in much the leſs quantity concur to the conſtitution of the concrete, do but meet with a body diſpoſed to receive their impreſſions, it is very poſſible, that they may work more powerfully on it than the other parts of the ſame concrete, of which the eye judgeth it altogether to conſiſt.

That there are divers concretes as to ſenſe, ſimilar, whoſe different parts have contrary qualities; as rhubarb and oil-olive.

THIS I have made out to ſome ingenious men, by ſhewing, that though ſallad-oil be generally reputed to conſiſt of fat and unctuous particles, and therefore to be a great reſiſter of corroſion; yet it contains in it ſharp and piercing parts, which meeting with a diſpoſed ſubject, do more powerfully operate, than the purely oleaginous ones. As we endeavoured to evince, by keeping for a ſhort while, in a gentle warmth, ſome pure oil-olive, upon a quantity of filings of even crude copper: for from them the liquor extracted an high tincture betwixt green and blue, like that, which ſuch filings would have given to diſtilled vinegar, which, according to chymiſts notions, obtains that colour, by making with its acid and corroſive ſalt a real ſolution of ſome part of the copper, as may appear by the recoverableneſs of the metal out of it. Another proof or two of the acrimony of ſome of the parts of oil, we may elſewhere give you. But now we ſhall rather confirm our anſwer to your queſtion, by two or three examples of cures performed by unlikely remedies.

I WENT once to viſit an ingenious Helmontian, whom I found ſick on his bed; and having by the ſymptoms of his diſeaſe diſcerned it to be a pleuriſy, I talked with him of ſeaſonably opening a vein, but he was reſolved againſt it; and told me he would cure himſelf by a remedy, which at firſt ſeems as likely to increaſe ſuch a diſeaſe as phlebotomy is to cure it; namely, by the uſe of *Helmont's laudanum opiatum*, which in effect did in three or four days cure him, and ſince, he, without bloodletting, cured ſome others with it: which I the leſs wonder at, becauſe of my having obſerved, that opium (with which unſkilful men ſeldom tamper without danger) if duly corrected and prepared, proves ſometimes a great reſolver, and commonly a great ſudorifick; inſomuch, that I have known it make a perſon copiouſly ſweat, who often complained to me, that other diaphoreticks had no ſuch operation on him.

Of improbable cures, viz. of a laudanum opiatum.

I HAVE oftentimes ſeen coughs ſtrangely abated by the uſe of a remedy, which I have not long ſince told you how I prepare; and with which (I remember) in a pretty child you, *Pyrophilus*, know, and who is now very well, I was ſo happy as to repreſs in a few hours a violent cough, that threatned her with ſpeedy death; and yet this medicine has ſo eminent a ſaltneſs, that the tongue can ſcarce ſuffer it: and how much the uſe of ſalt things, is by many phyſicians condemned in coughs, (and indeed in many caſes not without reaſon) I need not tell you. And with exceedingly piercing eſſence or ſpirit of man's blood, I have known, notwithſtanding its being very ſaline, and its manifeſtly

Of curing coughs and conſumptions by ſaline medicines.

manifeſtly heating the patient, eſpecially for the firſt four or five days, ſtrange things performed, even in a deplorable and hereditary conſumption. This, *Pyrophilus*, brings into my mind ſomething, that, it may be, you will think odd; which is, that having had occaſion to adviſe, for a perſon of high quality, with a very ancient Galeniſt, that in his own country was looked upon as almoſt an oracle, and particularly in reference to phthiſical conſumptions, which was there a vulgar diſeaſe; he confeſſed to me, that although his having fallen into it himſelf, made him very ſolicitous to find a cure for it; and though he had, in his long and various practice, made trial of great variety of methods and remedies for the cure of that diſeaſe, yet that, with which he cured himſelf, and afterwards the generality of his chief patients, was principally ſulphur melted and mingled in a certain proportion to make it fit to be taken, in a pipe, with beaten amber or a cephalick herb. The particular circumſtances of his method I cannot now ſet you down, not having by me the paper, wherein they were noted; but, if I miſtake not, the herb, with which he mingled the brimſtone of flour of ſulphur, was colts-foot or betony; and I well remember, that what he looked upon as the chief and ſpecifick remedy in his way of curing, was the ſmoke of the ſulphur; the other ingredients being added, not ſo much for their being proper enough for the diſeaſe, as their helping to fill the pipe, and thereby to allay the pungency, wherewith the ſmoke, if afforded by a pipe filled with brimſtone alone, would be qualified. But yet this ſulphureous ſmoke is ſo predominant in the remedy, that he uſed to have a ſyrup in readineſs to relieve thoſe, whom the acrimony of the fumes ſhould make very ſore, and perhaps bliſter on the one ſide of their mouths, or throats; which accident he provided for, by that cooling and healing ſyrup, without being thereby diſcouraged from proſecuting the cure with the ſame remedy; wherewith a perſon, very curious and rich, has ſolemnly aſſured me, that himſelf has cured divers conſumptions, and particularly in a lady, even in health very lean, that he named to me, as being one I then knew. Now we know, that phyſicians generally, and in moſt caſes juſtly, forbid acid things to thoſe, that have exulcerated or tender lungs; and how highly acid and piercing the ſmoke of ſulphur is, the chymiſts can beſt tell you, who, by catching it, and condenſing it in glaſſes ſhaped almoſt like bells, obtain from it that very corroſive liquor, which readily diſſolves iron, being the very ſame, that is commonly called *Oleum ſulphuris per campanam:* and yet it ſeems, that either the theory of conſumptions is miſunderſtood, or that the drying quality of the ſulphureous ſteam, and its great power to reſiſt putrefaction, and as it were embalm the lungs and ſeaſon the blood, are conſiderable enough to account for the harm, which its acidity may do.

Of the curing phthiſical conſumptions by the acid ſmoke of ſulphur.

EELS are ſo commonly eaten by perſons of both ſexes, without being taken notice of for any quality, except their crudity, that one would ſcarce believe ſuch a ſtinking and odious medicine, as that of their livers and galls, dried ſlowly in an oven, ſhould be more proper for any thing, than to make the taker vomit: and yet *Helmont* in divers places ſpeaks of the medicine, as if it had kept multitudes of women from dying of hard labour. And ſince him, *Panarola* in his *New Obſervations* highly extols it. And I knew a very famous empirick, who had very few other ſecrets, and ſcarce any one ſo great to get reputation and money by. And I remember alſo, that ſome years ſince I had occaſion to give it to the wife of a very ingenious phyſician, of whom the midwives and her huſband almoſt deſpaired, and (as ſhe afterwards told me her ſelf) each doſe made her throws (which before had left her) return; and at length ſhe was ſafely delivered, ſhe ſcarce knew how. But I found double the doſe preſcribed by *Helmont* requiſite to be uſed at laſt, and that the quantity of a walnut of the powder of theſe livers given in Rheniſh or white-wine, and when the ſtomach was moſt empty, was no more than ſuch a caſe required.

The uſe of the livers and galls of eels in expediting the hard labour of women.

SCORPIONS being venomous creatures, to ſuffocate and infuſe them in oil, might ſeem the way to make it poiſonous; if experience did not aſſure us, that this oil is ſo far from being ſuch, that it cures the invenomed bitings of ſcorpions; which effect, now that the phyſicians find it upon trial to be true, they confeſs to be rational; and aſcribe it, how juſtly I now examine not, to the attraction of the poiſon received into the body by that, which is outwardly applied to the hurt. And *Piſo* informs us, that amongſt the Braſilians, whoſe country is ſo much infeſted with venomous creatures, *it is the moſt general cure* to draw out the poiſon, by applying to the hurt the beaten body of the beaſt, that gave it. As likewiſe in *Italy*, they account the cruſhing of the very ſcorpion, that has bit a man, upon the bitten place, for a moſt ſpeedy and effectual remedy. And I remember, that here in *England* the old man, whom you have ſeen going about with vipers, toads, *&c.* to ſell, told me, that when he was dangerouſly bitten by a viper, and all ſwelled by the poiſon of it; a great part of his cure was the outward application of venomous creatures, ſtamped till they were brought to a conſiſtence fit for that purpoſe.

The unlikely cure of venom by oil of ſcorpions.

THAT fluxes are the general and endemical diſeaſes in *Ireland*, I need not tell you; and yet I remember, that having occaſion to conſult the ancienteſt and moſt experienced phyſician of that nation, Dr. *F.* about the cure of it, he aſſured me, that though during his very long practice he had found divers remedies very proſperous, ſome on one ſort of patients, and ſome on another; yet the medicine he moſt relied on, was this: To take unſalted butter, and boil it gently till a pretty part was conſumed; ſkimming it diligently from time to time, whilſt it ſtands over the fire; and of this butter melted, to give now and then a conſiderable quantity, according as the patient is able to bear it. A remedy, which, at the firſt propoſal, may ſeem more likely to put a man into a flux, than to cure him of one. And yet the

And of fluxes by freſh butter melted.

ſame

ſame remedy, which, he ſuppoſed to benefit by mitigating the ſharp humours, and preſerving the entrails from their corroſion, was afterwards much commended to me by another ancient *Iriſh* phyſician, who was eſteemed among the doctors the next in eminency to him that I have named.

CHAP. XIX.

I SHOULD not here, *Pyrophilus*, add any thing to what I have already ſaid above in favour of the uſe of even odd ſpecificks, but, that finding at every turn, that the main thing, which does (really or in pretence) prevail with many learned phyſicians (eſpecially in a famous univerſity you have viſited abroad) to reject ſpecificks, is, that they cannot clearly conceive the diſtinct manner of the ſpecificks working; and think it utterly improbable, that ſuch a medicine, which muſt paſs through digeſtions in the body, and be whirled about with the maſs of blood to all the parts, ſhould, neglecting the reſt, ſhew it ſelf friendly to the brain (for inſtance) or the kidneys, and fall upon this or that juice or humour rather than any other. But to this objection, which I have propoſed as plauſible as I can readily make it, I ſhall at preſent but briefly offer, according to what has been hitherto diſcourſed, theſe two things.

That it is very hard to give an intelligible explication of the operation of electives, and other common medicaments, which are not ſpecifics, 280, 281.

AND firſt, I would demand of theſe objectors a clear and ſatisfactory, or at leaſt an intelligible explication of the manner of working of divers other medicaments, that do not paſs for ſpecificks; as how rhubarb purges choler, and hellebore melancholy rather than other humours; how ſome medicines, that have endured a ſtrong fire, as *Antimonium diaphoreticum*, and *Bezoardicum minerale* well made, are yet oftentimes ſtrongly ſudorifick; why the infuſion of *Crocus metallorum* or of glaſs of antimony, though it acquire no pungent, or ſo much as manifeſt taſte, whereby to vellicate the palate or the tongue, are yet violently both vomitive and cathartick; and how mercury, which is innoxiouſly given in many caſes crude to women in labour and others, does eaſily acquire, beſides many other more abſtruſe medicinal qualities, not only an emetick or purgative, but a ſalivating faculty. For I confeſs, that to me, even many of the vulgar operations of common drugs ſeem not to have been hitherto intelligibly explained by phyſicians, who are yet, for aught I have obſerved, to ſeek for an account of the manner, how diureticks, how ſudorificks, how ſarcoticks, and how many other familiar ſorts of medicines, which thoſe, that conſider them ſlightly, are wont to think they underſtand thoroughly, perform their operations. Nay, I much queſtion, whether the generality of phyſicians can yet give us a ſatisfactory account, why any ſort of medicine purges in general: and he, that in particular will ſhew me, where either the peripatetick, or Galenical ſchools, have intelligibly made out, why rhubarb does particularly purge choler, and ſenna more particularly phlegm, *erit mihi magnus Apollo*. For I ſee not how from thoſe narrow and barren principles of the four elements, the four humours, the four firſt qualities (and the like) effects, far leſs abſtruſe than the operations of purging medicines, can ſatisfactorily be deduced. Nor can I find, that any thing makes thoſe phyſicians, that are unacquainted with the philoſophy, that explains things by the motions, ſizes, and figures of little bodies, imagine they underſtand the account, upon which ſome medicines are purgative, others emetick, *&c.* and ſome purgative in ſome bodies, vomitive in other, and both purgative and vomitive in moſt; but becauſe they never attentively inquire into it.

BUT (which is the next thing I have to repreſent) if we duly make uſe of thoſe fertile and comprehenſive principles of philoſophy, the motions, ſhapes, magnitudes and texture of minute parts of matter; it will not perhaps be more difficult to ſhew, at leaſt in general, that ſpecificks may have ſuch operations, as are by the judicious and experienced aſcribed to them, than it will be for thoſe, that acquieſce in the vulgar principles of philoſophy and phyſick, to render the true reaſons of the moſt obvious and familiar operations of medicines. And though the ſame objection, that is urged to prove, that a ſpecifick cannot befriend the kidneys, for example, or the throat rather than any other parts of the body, lies againſt the noxiouſneſs of poiſons to this or that determinate part; yet experience manifeſts, that ſome poiſons do reſpect ſome particular part of the body, without equally (if at all ſenſibly) offending the reſt: and we ſee that cantharides in a certain doſe are noxious to the kidneys and bladder, quickſilver to the throat, and the glandules thereabouts, ſtrammonium to the brain, and opium to the animal ſpirits and genus nervoſum. And if you call to mind, what we have formerly deduced to make it out, that a human body is an engine, and the medicines operate in it as finding it ſo; we need not think it ſo ſtrange, that there being many ſtrainers, if I may ſo call them, of differing textures, ſuch as the liver, ſpleen, and kidneys, and perhaps divers local ferments reſiding in particular parts, and a maſs of blood continually ſtreaming through all the parts of the body, a medicine may be quickly, by the blood, carried from any one part to any other, and the blood, or any humour mingled with it, may be as eaſily carried to the medicine, in what parts ſoever it be; and the remedy thus admitted into the maſs of blood may, in its paſſage through the ſtrainers, be ſo altered, either by leaving ſome of its parts there, or by having them altered by the abovementioned ferments, or by being aſſociated with ſome other corpuſcles, it may meet with in its paſſage; whereby the ſize, or figure, or motion of its ſmall parts may be changed; or, in a word, it may by ſome of thoſe many other ways, which might, if this eſſay were not too prolix already, be propoſed and deduced, receive ſo great an alteration, in reference either to ſome or other of the ſtrainers, or other firmer parts of the body, or to the diſtempered blood, or ſome other fluid and peccant matter, that it needs not ſeem impoſſible, that by that time the medicine (crum-

That poiſons do reſpect particular parts, and therefore medicines may do it.

General explications of the manner, how theſe operations of ſpecificks may proceed.

bled

bled as it were in minute corpuſcles) arrives at the part or humour to be wrought upon, it may have a notable operation there. I mean *part* as well as *humour*, becauſe the motion, ſize, or ſhape of the medicinal corpuſcles in the blood, though not by ſenſe diſtinguiſhable from the reſt of the liquor they help to compoſe, may be ſo conveniently qualified, as to ſhape, bulk, and motion; as to reſtore the ſtrainers to their right tone or texture, as well as the blood to its free and natural courſe; by reſolving and carrying away with them ſuch tenacious matter, as ſtuffed or choaked up the ſlender paſſages of the ſtrainer, or at leaſt ſtraitned its pores, or vitiated their figure. And the ſame ſanative corpuſcles may perchance be alſo fitted to ſtick to, and thereby to ſtrengthen ſuch fibres of the ſtrainers, or ſuch other firmer parts of the body, as may need congruous corpuſcles to fill up their little unſupplied cavities.

MEATS, that are ſalt, and tartareous, whilſt they are whirled about in the maſs of blood, may by the other parts of that vital liquor be ſo diluted and kept aſunder ſo, as not to be offenſive to any part: when they come to be ſeparated by the parenchyma of the kidneys, from the ſweeter parts of the blood, that did before temper and allay them, they eaſily, by their ſaline pungency, offend the tender ureters and membranous bladders of thoſe, that are troubled with the ſtone or ſtrangury. And perchance it is upon ſome ſuch account, that cantharides are more noxious to the bladder than to other parts of the body. And as ſalt meat thus grows peculiarly offenſive to the reins and bladder; ſo a ſpecifick, diſpoſed to be diſſolved, after a peculiar manner, may, in the body, either preſerve or acquire, as to its minute parts, a friendly congruity to the pores of the kidneys, liver, or other ſtrainers equally, when diſtempered; as I formerly obſerved to you, that new-milk ſweetned with ſugar-candy, though it be not wont ſenſibly to affect any other part of the body, nor would have ſenſibly affected the kidneys themſelves, had they not been diſordered; yet after the troubleſome operation of cantharides, it had a very friendly effect upon the diſtempered parts. Thus a ſpecifick for one diſeaſe may be reſolved in the body into minute particles of ſuch figure and motion, that being fit to ſtick to other corpuſcles of peccant matter, which, by their vehement agitation, or other offenſive qualities diſcompoſe the body and make it feveriſh, may allay their vehement motion, and by altering them, as to bigneſs and ſhape, give them new and innocent qualities, inſtead of thoſe noxious ones they had before.

ANOTHER ſpecifick may diſſolve the groſs and ſlimy humours, that obſtruct the narrow paſſages of the veins; as I have obſerved, that ſpirit of harts-horn, which powerfully opens other obſtructions, and reſolves ſtuffing phlegm in the lungs, will alſo, though more ſlowly, reſolve prepared flowers of ſulphur, crude copper, and divers other bodies; and alſo it may, by mortifying the acid ſpirit, that oftentimes cauſes coagulations in the blood, reſtore that vital liquor to its fluidity and free circulation, and thereby remove divers formidable diſeaſes, which ſeem to proceed from the coagulation or ropineſs of the blood; and, on the other ſide, the minute parts of ſome ſpecificks againſt a contrary diſeaſe may ſomewhat thicken and fix the too thin and agitated parts of the blood, or of ſome peccant matter in it, by aſſociating themſelves therewith; as the nimble parts of pure ſpirits wine, and thoſe of high rectified ſpirit of urine, will concoagulate into corpuſcles, bigger and far leſs agile. And the ſame ſpirit of wine it ſelf, with another liquor I make, will preſently concoagulate into a kind of ſoft, but not fluid ſubſtance. Nor is it ſo hard to conceive, that a ſpecifick may work upon a determinate part or humour, and let the others alone: as if you put, for inſtance, an egg into ſtrong vinegar, the liquor will operate upon and diſſolve all the hard ſhell, and yet leave the tender ſkin untouched. And if you caſt coral into the common rectified ſpirit of tartar, the far greater part of the liquor, though ſtrong and ſpirituous, will remain unaltered thereby, and may be, *integris viribus*, abſtracted from it; but the coral will preſently find out, or rather be found out by acid or acetous particles, and by incorporating it ſelf with them, take away their ſharpneſs: as in ſome caſes coral has been obſerved to do to ſour humours abounding in human bodies, thoſe humours being eaſily, by the circulating blood, brought (in their paſſage) to the coral, whilſt it perhaps remains in the ſtomach or guts. And though the circulation of the blood be ſufficient to bring, little by little, the acid particles of that liquor in its paſſages through the veſſels to work upon coral; yet in other medicines the operation may be more nimble, the remedy quickly diffuſing it ſelf through the maſs of blood, to ſeek, as it were, and deſtroy the acid parts, which it meets with blended with the reſt of the liquor. As ſpirit of urine being, inſtead of coral, put into the above mentioned ſpirit of tartar, will not (that I have obſerved) faſten it ſelf to the ſpirituous nor the phlegmatick parts of the liquor, but only to the acid ones, which it will mortify or deprive of their ſourneſs by concoagulating with them. And I ſee not, why it ſhould be more inconceivable, that a ſpecifick ſhould have a peculiar virtue to free the body from this or that peccant humour, and a benign congruity to the diſtempered ſpleen or liver, than that ſome cathartick ſhould purge electively, and ſome antidotes have peculiar virtues againſt ſuch poiſons, whoſe malignity particularly invades the brain or kidneys, or ſome other determinate part: the former of which the phyſicians, we reaſon with, ſcruple not to teach; and the latter of which is taught us not by them only, but by experience too.

That vinegar will operate on the ſhell, and not upon the other parts of the egg; with like inſtances of ſpecifick operations.

[OF the credibility of ſpecifick, and of the efficacy even of ſome unlikely ones, we might eaſily enough preſent you with more proofs and examples: but theſe may poſſibly be ſufficient for our preſent purpoſe; eſpecially if you duely conſider, that as phyſick had owed its beginning to experience, ſo thoſe, that practiſe it, muſt enlarge and rectify their principles according

That phyſick, as it begun by experience, ſo it muſt be enlarged and rectified by the new diſcoveries of experience.

according to the new diſcoveries, which are made from time to time of the operations and power of the productions whether of nature or of art. This conſideration I thought to inſiſt upon in my own expreſſions; but finding lately the ſame notion, which I had, to have been long ſince that of the ancient empiricks, I will ſum up what I meant to ſay, in their words, as I find them wittily delivered by *Celſus*, in that excellent preface, where having ſpoken in their ſenſe of the origin of phyſick, he continues, *Sic medicinam ortam, ſubinde aliorum ſalute, aliorum interitu pernicioſa diſcernentem à ſalutaribus: repertis deinde medicinæ remediis, homines de rationibus eorum diſſerere cœpiſſe; nec poſt rationem, medicinam eſſe inventam, ſed poſt inventam medicinam, rationem eſſe quæſitam.* 'Such was 'the origin of phyſick: by the recovery of 'ſome, and the death of others, it firſt made 'diſtinction between things ſovereign to heal, 'and things which are improper and deadly. 'And thus the remedies being found out, 'men began to diſpute of the reaſons of them. 'Nor was the art of medicine found out by the 'light of reaſon; but, medicine being found, 'the reaſon began to be inquired into.' And leſt the miſtaken name of empirick ſhould make you undervalue ſo uſeful a conſideration, which not the nature of their ſect, but that of the thing, ſuggeſted to them; I ſhall add, in favour of what we have delivered concerning experienced, though otherwiſe unlikely remedies, that it is a ſentence aſcribed to *Ariſtotle* (and, in my opinion, one of the beſt, that is aſcribed to him) *Ubi res conſtat, ſi opinio adverſetur rei, quærendam rationem, non rem ignorandam.* 'Where the matter is certain, if it 'be againſt the common opinion, the reaſon 'muſt be ſought, and not the matter of fact 'ſcrupled.'

AND certainly, *Pyrophilus*, though there be ſcarce any ſort of men, whoſe credulity may do the world more miſchief than that of phyſicians; yet perhaps, neither nature, nor mankind is much beholden to thoſe, that too rigidly, or narrowly, circumſcribe, or confine the operations of nature, and not ſo much as allow themſelves or others to try, whether it be poſſible for nature, excited and managed by art, to perform divers things, which they never yet ſaw done, or work by divers ways, differing from any, which by the common principles, that are taught in the ſchools, they are able to give a ſatisfactory account of.

TO the many things, which you may be pleaſed to apply to this purpoſe out of the precedent diſcourſe, divers others may be added, if, without tiring you, they may be now inſiſted on. It would ſcarce have been believed ſome ages ſince, by thoſe, that knew no other than vegetable purges and vomits, that a cup made of a concrete, inſuperable by the heat of human ſtomachs, ſhould, by having for a while, wine, or any ſuch other liquor, barely poured on it, to make an infuſion, without any ſenſible diminution of its own bulk or weight, and without any ſenſible alteration made in the colour, taſte or ſmell of the wine, communicate to it a ſtrongly emetick and cathartick virtue, and prove oftentimes vomitive, even when put up in the clyſters; and yet that this is performable by antimony, ſlightly prepared with ſalt-petre, or without addition, melted into a tranſparent glaſs, is commonly known to thoſe, that are not ſtrangers to the operations of the antimonial cup, and of the glaſs made of the ſame mineral. And much more ſtrange is that, which is affirmed by inquiſitive phyſicians upon their own trial of the common *crocus metallorum*, or ſomewhat corrected antimony wont to be ſold in ſhops; namely, that a few drachms of it, infuſed into ſome ounces of wine, will make the liquor work ſo ſtrongly, as if ſix or eight times the quantity had been ſteeped in it.

That the operations of the antimonial cup, glaſs of antimony, and crocus metallorum, would not have been credited in ancient times.

THOSE that believe, that all diaphoreticks muſt conſiſt of ſubtile, ſapid, and fugitive parts, as if only ſuch were eaſily ſeparated from each other, and agitated by the gentle heat of a human body, will ſcarce expect, that any body could, in a moderate doſe, be a good ſudorifick, that is ſo fixt as to be able to perſiſt divers hours in a good fire. And yet that *Antimonium diaphoreticum* is ſuch a concrete, is now very well known to many beſides chymiſts.

THAT a ſtone, and a ſtone too ſo fixed, that it will ſuſtain the violence of reverberated fire, and is conſequently very unlikely to be much wrought upon, or digeſted by the heat of a human ſtomach, ſhould be capable of agglutinating together the parts of broken bones, would ſeem impoſſible to many; but it is very well known to thoſe, that have made trial of the efficacy of the *Lapis oſſifragus*. For though I have ſometimes wondered at the fixedneſs of this ſtone above others in the fire, yet being for ſome days ſucceſſively drunk in wine, or aqua ſymphyti, to the quantity of about half a drachm, or more, it doth ſo wonderfully cement together the parts of broken and well-ſet bones, that it deſerves the name it commonly hath in the ſhops of *Oſteocolla*, and hath wonders related of it by ſeveral eminent, not only chymical, but Galenical writers.

Divers other inſtances alike incredible.

IT is almoſt incredible what *Quercetan* relates, of what himſelf ſaw done with it as to the cure of broken bones, without much pain, or any of the uſual grievous ſymptoms, within four or five days; ſo that to the ſtupendous virtue he aſcribes to this ſtone, both inwardly given, and outwardly applied in the form of a pultis, with only beaten geranium and oil of roſes or olives, he thinks fit to annex theſe words: *Quod incredibile videri poſſet, niſi præter me innumerabiles alii oculati & idonei teſtes extarent.* And indeed theſe need good proof to make a wary man believe ſo ſtrange a thing, ſince ſurgeons obſerve, that nature is wont to be forty days in producing a callus to faſten together the pieces of a broken bone. But to make this the more credible by the teſtimony of authors more Galenically inclined, *Mathiolus* relates, that in many the bones having been very well ſet (which circumſtance he requires as neceſſary) have had their broken parts conglutinated within three or four days. And not only that moſt experienced ſurgeon *Fabricius Hildanus* uſed it much in fractures,

with only a little cinnamon and ſugar to make it pleaſant; but the learned *Sennertus*, who ſomewhere calls its virtue admirable, thinks it requiſite, in his ſurgery, to give us this caution of it: *Verum in juvenibus, & iis qui boni ſunt habitus, callum nimis auget; quapropter cautè & non niſi in adultioribus exhibendus.* The warrantableneſs of which caution, and conſequently the ſtrange efficacy of oſteocolla, was, I remember, confirmed to me not long ſince by a ſkilfull phyſician, who hath particularly ſtudied its nature, and related to me, that ſome years ſince his mother, having by a fall broken her leg near the knee, had too ſuddenly, by the overmuch uſe of this ſtone, a callus produced in the part much bigger than he expected or deſired.

Fab. Cent. 3. Obſer. 90.

Lib. 5. part. 5. Cap. 1.

He that, before the ſalivating property of mercury was diſcovered, ſhould have told phyſicians of the deſpondent temper of theſe, we are now diſcourſing with, that beſides the known ways of diſburthening nature, (namely, by vomit, ſiege, urine, ſweat, and inſenſible tranſpiration) there were a ſort of remedies, that would make very large evacuations by ſpittle, and thereby cure divers ſtubborn diſeaſes, that had been found refractory to all ordinary remedies, would certainly have been more likely to be derided than believed by them; ſince no known remedy, beſides mercury, hath been, that I remember, obſerved to work regularly by ſalivation. For though ceruſs of antimony have been obſerved to make men, of ſome conſtitutions, apt to ſpit much, yet it works that way too languidly, to deſerve the name of a ſalivating remedy, and probably oweth the quality it hath of inclining to ſpit, to the mercurial part of the antimony, (wherewith the regulus, it is made of, abounds;) and therefore the greater their experience of the effects of medicinal operations ſhould be ſuppoſed to be, the greater indiſpoſition it would give them to credit ſo unallied a truth. And yet the reality of the fluxing property of quickſilver is long ſince grown paſt queſtion, and hath been found ſo uſeful in the cure of the moſt radicated and obſtinate venereal diſtempers, that I ſomewhat wonder thoſe phyſicians, that ſcruple not to employ as boiſterous ways of cure, have not yet applied it to the extirpation of ſome other diſeaſes; as ulcers of the kidneys, conſumptions, and even palſies, *&c.* wherein I am apt to think it may be as effectual, as in thoſe produced by luſt, and much more effectual than vulgar remedies, provided that the exceeding troubleſome way of working of ſalivating medicines be better corrected, than it is wont to be in the ordinary medicines employed to produce ſalivation, which they do with ſuch tormenting ſymptoms, that they are ſcarcely ſupportable. But if purified quickſilver be dexterouſly precipitated by a long and competent digeſtion, with a due proportion of refined gold, experience hath informed us, that the ſalivating operation of it may be performed with much leſs uneaſineſs to the patient. And that ſuch mercurial medicines, wherein the quickſilver is well corrected by gold, may produce more than ordinary effects, we have been inclined to believe, by the trials, which we procured by learned phyſicians to be made in other than venereal diſeaſes, of a gently working precipitate of gold and mercury, of which we may elſewhere ſet you down the proceſs.

[And now I am upon the diſcourſe of the peculiar operations of mercury, and of unuſual ways of evacuation, I am tempted to ſubjoin an odd ſtory, which may afford notable hints to a ſpeculative man, as it was related to me both in private, and before illuſtrious witneſſes, by the formerly commended chymiſt of the French king: he told me then a while ſince, that there is yet living a perſon of quality, by name Monſieur *de Vatteville*, well known by the command he hath or had of a regiment of *Switzers* in *France*, who, many years ago following the wars in the Low Countries, fell into a violent diſtemper of his eyes, which, in ſpite of what phyſicians and ſurgeons could do, did in a few months ſo increaſe, that he loſt the uſe of both his eyes, and languiſhed long in a confirmed blindneſs; which continued till he heard of a certain empirick at *Amſterdam*, commonly known by the name of *Adrian Glaſmaker* (for indeed he was a glazier) who being cried up for prodigious cures he had done with a certain powder, this colonel reſorted to him, and the empirick having diſcourſed with him, undertook his recovery, if he would undergo the torment of the cure; which the colonel having undertaken to do, the ſurgeon made him ſnuff up into each noſtril about a grain of a certain mercurial powder, which in a ſtrangely violent manner quickly wrought with him almoſt all imaginable ways, as by vomit, ſiege, ſweat, urine, ſpitting, and tears, within ten or twelve hours that this operation laſted, making his head alſo to ſwell very much: but within three or four days after this ſingle taking of the draſtick medicine had done working, he began to recover ſome degree of ſight, and within a fortnight attained to ſuch a one, that he himſelf aſſured the relater, he never was ſo ſharp-ſighted before his blindneſs. And the relater aſſured me, that he had taken pleaſure to obſerve, that this gentleman, who is his familiar acquaintance, would diſcern objects farther and clearer than moſt other men. He added, that Monſieur *de Vatteville* told the relater, he had purchaſed the way of making this powder of the empirick, and had given it to an eminent ſurgeon, one *Benoeſt* (an acquaintance of the relater's) by whom he had been cured of a muſket-ſhot, that had broken his thigh-bone, when the other ſurgeons would have proceeded to amputation; and that this *Benoeſt* had with this powder, adminiſtred as before is related, cured a gentlewoman of a cancer in the breaſt. All which, and more, was confirmed to the relater by the ſurgeon himſelf. But in what other ſtubborn and deplorable caſes they uſe this powder, I do not particularly remember. The preparation of it, which a chymiſt did me the favour to tell me by word of mouth, as a thing himſelf had alſo made, was in ſhort this: that the remedy was made by precipitating quickſilver with good oil of vitriol, and ſo making a turbith, which is afterwards to be dulcified by abſtracting

A ſtrange cure of blindneſs by a mercurial powder.

abſtracting twenty or twenty five times from it pure ſpirit of wine, of which freſh muſt be taken at every abſtraction. But I would not adviſe you to commend ſo furious a powder to any, that is not a very ſkilfull chymiſt and phyſician too, till you know the exact preparation, and particular uſes of it; the reaſon of my mentioning it here, being but that, which I expreſſed at the entrance upon this narrative.]

CHAP. XX.

Of univerſal medicines.

YOU will perchance wonder, *Pyrophilus*, that having had ſo fair an opportunity as the ſubject of his eſſay afforded me, of diſcourſeing to you about the univerſal medicine, which many Paracelſians, Helmontians, and other chymiſts talk of ſo confidently; I have ſaid nothing concerning the exiſtence, or ſo much as the poſſibility of it. But till I be better ſatisfied about thoſe particulars than yet I have been, I am unwilling either to ſeem to believe what I am not yet convinced of, or to aſſert any thing, that may tend to diſcourage human induſtry; and therefore I ſhall only venture to add on this occaſion, that I fear we do ſomewhat too much confine our hopes, when we think, that one generous remedy can ſcarce be effectual in ſeveral diſeaſes, if their cauſes be ſuppoſed to be a little differing. For the theory of diſeaſes is not, I fear, ſo accurate and certain, as to make it fit for us to neglect the manifeſt or hopeful virtues of noble remedies, wherever we cannot reconcile them to that theory. He that conſiders what not unfrequently happens in diſtempered bodies by the metaſtaſis of the morbifick matter, (as for inſtance, how that, which in the lungs cauſed a violent cough, removed up to the head may produce, as we have obſerved, a quick decay of memory and ratiocination, and a palſy in the hands and other limbs) may enough diſcern, that diſeaſes, that appear very differing, may eaſily be produced by a peccant matter of the ſame nature, only variouſly determined in its operations by the conſtitution of the parts of the body where it ſettleth: and conſequently it may ſeem probable to him, that the ſame ſearching medicine, being endowed with qualities deſtructive to the texture of the morbifick matter, where-ever it finds it, may be able to cure either all, or the greateſt part, of the diſeaſe, which the various tranſlation of ſuch a matter hath been obſerved to beget. Moreover, it oftentimes happens, that diſeaſes, that ſeem of a contrary nature, may proceed from the ſame cauſe variouſly circumſtanced; or (if you pleaſe) that of divers diſeaſes, that may both ſeem primary, the one is but ſymptomatical, or at moſt ſecondary in relation to the other; as a dropſy and a flow fever may, to unſkilful men, ſeem diſeaſes of a quite contrary nature, (the one being reputed a hot and dry, the other a cold and moiſt diſtemper) though expert phyſicians know they may both proceed from the ſame cauſe, and be cured by the ſame remedy. And in women experience manifeſts, that a great variety of different diſtempers, which by unſkilful phyſicians have been adjudged diſtinct and primary diſeaſes, and have been, as ſuch, unſucceſsfully dealt with by them, may really be but diſguiſed ſymptoms of the diſtempers of the mother or *genus nervoſum*; and may by remedies, reputed antihyſterical, be happily removed. To which purpoſe I might tell you, *Pyrophilus*, that I, not long ſince, knew a practitioner, that with great ſucceſs uſed the ſame remedies (which were chiefly volatile and reſolving ſalts) in dropſies, and in (not, ſymptomatical, but) eſſential fevers. And our ſelves have lately made ſome experiments of not much unlike nature, with a preparation of hartſhorn, of equal uſe in fevers and coughs, both of them primary. I might on this occaſion recur to divers of the remedies formerly mentioned in ſeveral places of this eſſay; ſince divers of them have been found effectual againſt diſeaſes, which, according to our common theory, ſeem to be little of kin one to another: and by telling you what I have obſerved concerning the various operations of *Helmont's laudanum*, of our *ens veneris*, and even of a medicine deviſed by a woman, the lady *Kent's* powder, I might illuſtrate what I have lately delivered: but it is high time for me to paſs on to another ſubject; and therefore I ſhall rather deſire you, in general, to conſider, whether or no ſeveral differing diſeaſes, and even ſome commonly ſuppoſed to be of contrary natures, be not yearly cured by the *Spaw* waters in *Germany*.

That the ſame matter may cauſe divers diſeaſes.

And the ſame medicine cure them.

AND to aſſiſt you in this inquiry, I ſhall addreſs you to the rare obſervations of the famous and experienced *Henricus ab Heer*, and to his *Spadacrene*; in the eighth chapter of which, he reckons among the diſeaſes, which thoſe waters cure, catarrhs, and the diſtempers, which (according to him) ſpring from thence; as the palſy, trembling of the joints, and other diſeaſes of kin to theſe, convulſions, cephalalgiæ, (I name them in the order, where I find them ſet down) hemicraniæ, vertigo, redneſs of the eyes, of the face, the eryſipelata, ructus continui, vomitus, ſingultus, obſtructions, and even ſcirrhus's, if not inveterate, of the liver and ſpleen, and the diſeaſes ſpringing thence; the yellow jaundice, *melancholia flatulenta ſeu hypochondriaca*, dropſies, gravel, ulcers of the kidneys, and carunculæ *in meatu urinario*, gonorrhœas, and reſembling affections, elephantiaſis or the leproſy, *fluor albus mulierum*, cancers and ſcirrhus's of the womb, fluxes and even dyſenteries; the worms (though very obſtinate, and ſometimes ſo copious as to be voided in his preſence, even with the urine) ſterility, and not only the ſcabies in the body and neck of the bladder, and clammy pituitous matter collected therein, beſides ulcers in the ſphincter of it: but he relates, upon the repeated teſtimony of an eminent perſon, that he names, and one whom he ſtyles *vir omni fide digniſſimus*, that this party being troubled with a very great ſtone in his bladder; and having had it ſearched by divers lithotomiſts, before he came to the *Spaw*, did, by very copiouſly drinking theſe waters, find, by a ſecond ſearch made by thoſe artiſts, that this ſtone was much diminiſhed the firſt year, and (by the ſame way of trial) that it was ſo the ſecond year. And of the cures of theſe diſeaſes, the phyſician mentions in the

An inſtance in the waters of the Spaw.

ſame

ſame chapter, as to many of them, particular and remarkable inſtances; and in the beginning of the next chapter, having told his readers, that he expects they ſhould ſcarce believe theſe waters can have ſuch a variety of virtues, *Cæterum*, ſays he, *ſi in Spaa maturè & conſtantibus naturalibus, vitalibuſque facultatibus venerint; aquaſque quo dicemus modo biberint, indubitè quæ dixi vera eſſe fatebuntur.* And though we be not bound to believe (nor doth he affirm it) that the *Spaw*-waters do univerſally cure all the afore-mentioned diſtempers; yet it is very much, and makes much for our preſent purpoſe, that they ſhould in ſo many patients cure moſt of theſe diſtempers, and leſſen, if not cure, the reſt. And we may ſomewhat the better credit him, becauſe even where he reckons us the virtues of the *Spaw*, he denies it ſome, which other phyſicians aſcribe to it. And it is very conſiderable, what he ſubjoins in theſe words: *Pauciſſimos enim vel nullos Spadæ incolas capitis doloribus, cardialgiâ, calculo, obſtructionibus renum, hepatis, lienis, meſaraicarum, laborantes invenies; ictericos, hydropicos, podagricos, ſcabioſos, epilepticos, quod ſciam, nullos:* 'You will find very few of thoſe, who 'dwell at the *Spaw*, who are troubled with 'the head-ach, ſtone, obſtructions of the kid-'neys, liver, ſpleen, or meſaraick veins; none 'at all, who were troubled with the jaundice, 'dropſy, gout, itch, or falling-ſickneſs.' But that, which I moſt deſire you to take notice of, is, that beſides all the above-mentioned diſeaſes, I find, that he aſcribes to theſe waters the virtues of curing ſuch, as are counted of a contrary nature, and are thought to require contrary remedies. For beſides that, he expreſly affirms, in the beginning of the eighth chapter, that theſe waters being endowed with the virtues both of hot and cold minerals, they cure both hot and cold affections, in the ſame patients, and in differing bodies, and that contrary effects are performed by them; he hath, after ſome pages, this paſſage, which may go for an illuſtrious proof of that he hath aſſerted: *Inter cætera* (ſaith he, ſpeaking of the *Spaw*-waters) *menſibus movendis in primis idonea, quod millies experientia comprobavit: et tamen nimium ecrum fluxum quovis alio medicamento felicius ſiſtit.* 'Among other qualities, it moveth the month-'ly evacuations, as hath been proved by a thou-'ſand trials: and yet it ſtops the immoderate 'flux of them more happily than any other 'medicine.'

THESE teſtimonies, *Pyrophilus*, of our experienced author would perhaps obtain the more credit with you, if you had ſeen what I lately had the opportunity to obſerve in a hot and dry ſeaſon, at our own *Tunbridge*-waters in *Kent*, when I was there to drink them. And therefore I ſhall again invite you not only to conſider, whether one potent remedy, ſuch as it may be, may not be able to cure variety of diſeaſes, and ſome ſuppoſed to be of contrary natures; but whether or no divers perſons, on whom the received *methodus medendi* hath been long and fruitleſly employed, be not by their tired and deſpondent phyſicians themſelves ſent thither, and there cured of their abſtruſe and obſtinate diſeaſes, by remedies prepared by nature without the aſſiſtance of art: for if you duly reflect on this conſpicuous obſervation, and conſider, how much it is poſſible for art to meliorate and improve moſt (eſpecially mineral) remedies, afforded us by nature, you would probably dare to hope, that medicines might be prepared of greater efficacy, and applicable to more diſeaſes, than they, who think the more received theory of diſeaſes (from which yet very eminent phyſicians, in divers particulars, ſcruple not to recede) incapable of being rectified; and that judge of all remedies by them, that are publickly venal in apothecaries ſhops, will allow themſelves ſo much as to hope.

Of the reaſon and deſign of the author's diſcourſe concerning the Methodus medendi. *and his deſcending to other particulars, which may be thought improper for him.*

IF now you demand, *Pyrophilus*, If I think that every particular, which hath contributed to ſwell this diſcourſe into a bulk ſo diſproportionate to that, which the title of an eſſay promiſed, to directly belong to the art of phyſick? I ſhall leave it to the judicious *Celſus* (whom learned men have ſtyled the Roman *Hippocrates*) to anſwer for me, and he will tell you, that *quanquam multa ſint ad ipſas artes non pertinentia, tamen eas adjuvant excitando artificis ingenium.* I ſuppoſe I need not remind you, *Pyrophilus*, that it was not my deſign, in what hath been repreſented, to ſubvert thoſe principles of the *methodus medendi*, from which no ſober phyſicians themſelves recede, and in which they unanimouſly acquieſce; and that I much leſs intend to countenance thoſe venturous empiricks, who, without any competent knowledge of anatomy, botanicks, and the hiſtory of diſeaſes, think receipts or proceſſes alone can enable them to cure the ſickneſſes they know not, and who would perſuade men to lay by, as needleſs, a profeſſion, of whoſe uſefulneſs to mankind, we may elſewhere have occaſion to diſcourſe. No, *Pyrophilus*, without peremptorily aſſerting any thing, I have but barely repreſented the notions I have mentioned concerning the *methodus medendi*, as things probable enough to deſerve to be impartially conſidered; that in caſe they prove fit to be declined, they may appear to have been rejected, not by our ſuperciliouſneſs or lazineſs, but (after a fair trial) by our experience: and in caſe they ſeem fit to be approved, they may prove additional inſtances of the uſefulneſs of natural philoſophy to phyſick. Which uſefulneſs, *Pyrophilus*, if I have in any conſiderable meaſure been ſo happy as to make out, I ſhall not think the time (and much leſs the pains) I have beſtowed upon that theme, miſſpent. For, I muſt confeſs to you, *Pyrophilus*, that to me it ſeems, that few things ought more to endear to us the ſtudy of natural philoſophy, than that (according to the judicious ſentence of our *Celſus*, *Rerum naturæ contemplatio*, ſaith he, *quamvis non faciat medicum, aptiorem tamen medicinæ reddit:*) 'The contem-'plation of nature, though it maketh not a 'phyſician, yet it fits him to learn phyſick:' A deeper inſight into nature may enable men to apply the phyſiological diſcoveries made by it, (though ſome more immediately, and ſome leſs directly) to the advancement and improvement of phyſick.

AND

AND I well enough know, *Pyrophilus*, that inſtead of writing the eſſay to ſuch a one as you, if I ſhould write it to the more critical and ſeverer ſort of readers, they would be apt to think, both that it is impertinent for me, who do not profeſs to be a phyſician, to treat prolixly of matters medicinal; and that it may appear ſomewhat below me, in a book, whoſe title ſeems to promiſe you philoſophical matters, to inſert I know not how many receipts. But I ſhall not ſcruple to tell ſuch a perſon as *Pyrophilus*, that ſince my method required, that I ſhould ſay ſomething to you of the therapeutical part of phyſick, I thought, that Chriſtianity and humanity it ſelf obliged me not to conceal thoſe things, which, how deſpicable ſoever they may ſeem to a ſpeculative philoſopher, are yet ſuch, as, beſides that ſome of them may perhaps afford improveable hints touching the nature of remedies, if not alſo of diſeaſes, experience hath encouraged me to hope, that others may prove uſeful to the ſick. And as for the inſerting of receipts, even in books of philoſophical ſubjects, I have not done it altogether without example. For not only *Pliny*, a perſon of a great dignity as well as parts, and friend to one of the greateſt Roman emperors, hath left us in a book, where he handles many philoſophical matters, ſtore of particular receipts; but our chancellor, the Lord *Verulam*, hath not diſdained to record ſome. And as for that induſtrious benefactor to experimental knowledge, the learned and pious *Merſennus*, his charity made him much more fearful to neglect the doing what good he could to others, than to venture to leſſen his reputation by an *indecorum*, that in a mathematical book, and in a chapter of arithmetical combinations, he brings in not only a remedy againſt the eryſipelas, but even a medicine for corns, where he tells us, that they may be taken away, by applying and daily renewing for ten days, or a fortnight, the middle ſtalk, that grows between the blade and the root (for that I ſuppoſe he means by the unuſual word *thallum*) of garlick, bruiſed. Nor is it without examples, though ſomewhat contrary to my cuſtom in my other writings, that in this, and the four precedent eſſays, I have frequently enough alledged the teſtimonies of others, and divers times ſet down proceſſes or receipts, not of my own deviſing. For even among profeſſed and learned phyſicians, ſcarce any thing is more common, than on ſubjects far leſs of kin to paradoxes, than moſt of thoſe I have been diſcourſing of, to make uſe of the teſtimonies and obſervations of other approved writers, to confirm what they teach. And not now to mention the voluminous books of *Schenkius Scolzius*, that famous and experienced practitioner *Riverius* himſelf hath not been aſhamed to publiſh together a good number of receipts, given him by others, under the very title of *Obſervationes communicatæ*: and *Henricus ab Heer* hath, among his *Obſervationes oppido raræ*, divers receipts, that came from mountebanks, and even gypſies. And therefore I hope, that you, who know, that it is not after every body, that I would ſo much as relate an obſervation, or mention a medicine, as thinking them probable, will eaſily excuſe one, that hath much fewer opportunities, than a profeſſed phyſician, to try remedies himſelf; if treating of ſubjects not ſo familiar, I chooſe to countenance what I deliver by the teſtimonies of ſkilful men, and if I ſcruple not to preſerve in theſe papers ſome not deſpicable remedies, as well of abler men, as of my own, that otherwiſe would probably be loſt. But of this practice I may elſewhere have occaſion to give you a more full apology, by ſhewing, how much it may conduce to the enriching and advancement of phyſick; an art, with whoſe praiſes I could long entertain you, if I were at leiſure (and durſt allow my ſelf) to exhauſt common places.

AND yet give me leave to tell you, that man is ſo noble a creature, and his health ſo requiſite to his being able to reliſh other goods; and oftentimes alſo to the comfortable performance of what his conſcience, his country, his family, his neceſſities, and perhaps his allowable curioſity challenge from him, that I wonder not ſo much at thoſe antient heathens, that, being polytheiſts and idolaters, thought themſelves obliged, either to refer ſo uſeful an art, as that of phyſick, to the gods, or godlike perſons; or to add thoſe, that excelled in ſo noble a faculty, to the number of thoſe they worſhipped. For my part, *Pyrophilus*, a very tender and ſickly conſtitution of my own (much impaired by ſuch unhappy accidents as falls, bruiſes, *&c.*) hath, beſides (as I hope) better motives of compaſſion, given me ſo great a ſenſe of the uneaſineſſes, that are wont to attend ſickneſs, that I confeſs, if I ſtudy chymiſtry, it is very much out of hope, that it may be uſefully imployed againſt ſtubborn diſeaſes, and relieve ſome languiſhing patients with leſs pain and trouble, than otherwiſe they are like to undergo for recovery. And really, *Pyrophilus*, unleſs we will too groſly flatter our ſelves, we can ſcarce avoid both diſcerning and deploring the ineffectualneſs of our vulgar medicines, not only Galenical, but chymical, (for an active body may yet be but a languid remedy.) For beſides that many, that recover upon the uſe of them, endure more for health, than many, that are juſtly reckoned among martyrs, did for religion; beſides this, I ſay, we daily meet with but too many in the caſe of that bleeding woman, mentioned in the goſpel, of whom it is ſaid, that ſhe had ſuffered many things of many phyſicians, and had ſpent all that ſhe had, and was nothing bettered, but rather grew worſe. And therefore I reckon the inveſtigation and divulging of uſeful truths in phyſick, and the diſcovering and recommending of good remedies, among the greateſt and moſt extenſive acts of charity, and ſuch, as by which a man may really more oblige mankind, and relieve more diſtreſſed perſons, than if he built an hoſpital. Which perhaps you will not think raſhly ſaid, if you pleaſe but to conſider, how many the knowledge of the ſalivating, and other active properties of mercury, and of its enmity to putrefaction and diſtempers ſpringing thence, have cured of ſeveral diſeaſes; and conſequently how many more patients,

Mark v. 26.

tients, than have recovered in the greateſt hoſpital in the world, are obliged to *Carpus*, and thoſe others, whoever they were, that were the firſt diſcoverers of the medical efficacy of quickſilver. And for my own particular, *Pyrophilus*, though my youth and condition forbid me the practice of phyſick, and though my unhappy conſtitution of body kept divers remedies from doing me the ſame good they are wont to do others; yet having more than once prepared, and ſometimes occaſionally had opportunity to adminiſter medicines, which God hath been ſo far pleaſed to bleſs on others, as to make them relieve ſeveral patients, and ſeem (at leaſt) to have ſnatched ſome of them almoſt out of the jaws of death; I eſteem my ſelf, by thoſe ſucceſſes alone, ſufficiently recompenſed, for any toil and charge my inquiries into nature may have coſt me. And though I ignore not, that it is a much more faſhionable and celebrated practice in young gentlemen, to kill men, than to cure them; and that miſtaken mortals think it the nobleſt exerciſe of virtue to deſtroy the nobleſt workmanſhip of nature, (and indeed in ſome few caſes the requiſiteneſs and danger of deſtructive valour may make its actions become a virtuous patriot) yet when I conſider the character given of our great maſter and exemplar, in that ſcripture, which ſays, *That he went about doing good, and healing all manner of ſickneſs, and all manner of diſeaſes among the people*; I cannot but think ſuch an imployment worthy of the very nobleſt of his diſciples. And I confeſs, that if it were allowed me to envy creatures ſo much above us as are the celeſtial ſpirits, I ſhould much more envy that welcome angel's charitable imployment, who at ſet times diffuſed a healing virtue, through the troubled waters of *Betheſda*, than that dreadful angel's fatal imployment, who in one night deſtroyed above a hundred and fourſcore thouſand fighting men. But of the deſireableneſs of the ſkill, and willingneſs to cure the ſick, and relieve not only thoſe, that languiſh in hoſpitals, but thoſe that are rich enough to build them, having elſewhere purpoſely diſcourſed, I muſt now trouble you no longer on this theme, but implore your much-needed pardon, for my having been (beyond my firſt intentions) ſo troubleſome to you already.

That this employment is better than the more faſhionable of deſtroying valour.

Acts x. 38. Mat. iv. 24. Joh. v. 14. 2 Kings xix. 35. *The angel's charitable employment at Betheſda more deſireable than his, who deſtroyed in one night 180,000 fighting men.*

AN APPENDIX TO THE FIRST SECTION of the SECOND PART.

Advertiſements touching the following APPENDIX.

I SCARCE doubt, but it will be expected, that I ſhould annex to the foregoing treatiſe thoſe receipts and proceſſes, which ſeem to be here and there promiſed in it: But I deſire it may be conſidered, that ſome paſſages, which an unattentive reader may have miſtaken for abſolute promiſes, are indeed but profers conditionally made to a particular perſon; and ſo not engaging me, till the condition (which was his deſiring the thing mentioned to him) be on his part performed. And as for the other things, which every reader may ſuppoſe to be promiſed him, I have at hand this general excuſe; that at leaſt I promiſed nothing to the publick, whatever promiſes I may have made in the foregoing Eſſays, having together with them been addreſſed to a private friend. And I have two or three ſpecial reaſons to inſiſt on this excuſe; for divers of my choicer books and papers having not long ſince unhappily miſcarried through the negligence of ſome men, and fraud of others, it is not now poſſible for me to retrieve ſome of the things I was maſter of, when I promiſed them. And then to reviſe carefully all the papers, that remain in my hands, of affinity with the paſt treatiſes, would take up more time, than is allowed me by other ſtudies and employments, which I think of greater moment, or at leaſt wherein I am much more concerned, than to give this book at preſent a full or accurate Appendix.

BUT though I might, upon theſe and other reaſons, wholly excuſe my ſelf from the trouble of adding any appendix; yet becauſe the communicating of good medicines is a work of charity, and thoſe unpoliſhed and immethodical notes, that may perchance diſparage an author, may yet relieve many a patient; I am willing to do what my occaſion will permit: and finding among my papers many looſe ſheets, concerning ſpirit of harts-horn, blood, *&c.* written divers years ſince to a friend, I chuſe rather to publiſh them juſt as I find them with *Pyrophilus*'s name, employed in convenient places, and to add ſome unpromiſed receipts in ſtead of thoſe, that are loſt, than be altogether wanting to what may be expected from me. I know,

know, that what I deliver concerning ſome of the following preparations, may by ſeverer criticks be thought ſomewhat unaccurate, and I confeſs I am of that mind my ſelf; but meeting with theſe collections in looſe ſheets among my old papers, I muſt either publiſh them as I find them, or take the pains to poliſh and contract them; which would require more time, than I can at preſent afford them. And much leſs can I ſtay to ſubjoin the hiſtories of the particular cures performed by the medicines, whoſe preparations I ſet down, though divers of them would not perhaps appear inconſiderable. But if I find by the entertainment of theſe papers, that it will be worth while to reviſe or enlarge them, I may, God permitting, be invited to do it, and either ſupply the things, that are here deficient, out of after obſervations, or papers now out of the way, or make amends for their omiſſion in ſubſtituting better things.

It will not at all ſurprize me, if ſome readers think me too prolix in delivering the preparations of harts-horn, ens Veneris, *&c.* with ſuch particular and circumſtantial obſervations. But my deſign being to gratify and aſſiſt thoſe that would make and uſe the remedies I recommend, the experience I have had of the difficulties moſt men find in the preparing things by the direction of chymical proceſſes not very expreſly ſet down, makes me apt to hope, that (I ſay not the great phyſicians or chymiſts, who may, if they pleaſe, leave them unperuſed; but) thoſe, for whom I principally intend my directions, will think my having made them ſo particular a very excuſable fault. And I make the leſs difficulty to ſuffer ſuch things, as perhaps I judge to be, in compariſon of others, but trifles, to paſs abroad; becauſe finding of late years, that many perſons of quality of either ſex, who ſcarce read any other than Engliſh books, have (as I hope) out of charity, or curioſity, or both, begun to addict themſelves to chymiſtry, and venture to be tampering with ſpagyrical remedies; it may not be unſeaſonable to ſupply them with ſome preparations, that may both ſave them time and charges, and put them upon the uſe of remedies, which, without being languid, are, if any thing diſcreetly given, ſafe and innocent, and wherein a little error either in the making or the adminiſtring will be far leſs prejudicial to the ſick, than if it were committed in the more vulgar, oftentimes, either falſly or obſcurely preſcribed) preparations they are wont to make of acid ſalts, mercury, antimony, and other minerals; whoſe activity for the moſt part makes them need to be ſkilfully prepared and judiciouſly given.

To the 483d Page.

The Iriſh lithotomiſt's receipt, for the ſtone in the bladder.

Rec. *Aquar. melon. citrullor. filipendulæ, petroſelin. ſyr. è 5 radicibus, ſyr. de Byſantiis, ana unc.* ij. *oxymelit. comp. unc.* j. *miſce; quartam mixti partem ſumas manè jejunus, & poſtea per octo horas à cibo & potu abſtineas, aliam ſumas partem eodem die poſt cœnam cum lectum intrare volueris. Denique ſequenti die reliquæ ſumantur partis ut primæ; tertio verò die,*

Rec. *Elect. lenit. drachm.* iij. *ſyr. roſat. ſolut. drachm.* ij. *pulp. tamarind. drachm.* j. *miſceantur ac in ſeri lactis unc.* iij. *diſſolvantur: totum bibas mane quatuor horis antè jus, quarto die ſumas mane ſequentis pulv. drachm.* j. *mixti inſequentis apozematis unc.* iiij. *& olei amygd. dulc. unc. ſem.*

Rec. *Cinerum vitri*, & ſcorpionum pulveris lapid. ſpongiæ, & lap. Judaici, acori, ſem. altheæ, millii ſolis, ſaxifragii ana drachm.* j. *ſem. lactucæ, 4 ſem. frigid. majorum ana drachm. ſem. trochiſcor. alkekengi, rad. pimpinellæ ana drachm.* ij. *fiat pulvis ſubtilis.*

Apozema.

Rec. *Parietariæ, rad. alth. ana* m.j. *ſem. petroſelini, glycyrrhiza ana unc. ſem. halicacabi unc.* j. *coq. in aq. pluviæ ſext.* 2. *& vini albiſſimi ſext.* j. *ad medietatis conſumptionem, & colatura melle hybernico dulceretur.*

Tum quarto illo die paſſerculum trogloditem ſalé antea conditum edas una cum cœna, et poſt cœnam lumbi, pubes, & tota renum regio oleis è granis citri & ſcorpion. liniantur, etſi poſſibile eſſet prædicta olea per meatum urinar. in veſicam injiciantur, ſitque dein è pulvere, apozemate, troglodite & oleis omni die utere, donec arenulæ aut lap. fragmenta una cum expulſis apparuerint.

Loco cinerum vitri ſumi poſſunt cineres camini & vires cinerum ſcorpionum ſupplere poteſt pulvis lumbricor. terreſtr. probè in vino lotorum & poſtea exſiccatorum.

N. B. [As far as I could conjecture by the diſcourſe I had with the owner of the receipt, by aſhes of glaſs he means the ſuperfluous ſaline ſubſtance, which the glaſs-men are wont to call *Sandiver*; but becauſe he did not explain himſelf ſo clearly, and we know not yet a way of burning glaſs to aſhes, I think it will be moſt adviſeable to ſubſtitute the wood-aſhes, which in the receipt it ſelf towards the cloſe of it are appointed for a ſuccedaneum.]

To the 497th Page.

[*Where the Vertues of the* Pilulæ Lunares *are touched at.*]

The great benefit, that has redounded to many patients, from the uſe of the ſilver pills, here briefly mentioned, and commended, invites me to communicate, as a conſiderable thing, the preparation of them, of which I do not pretend to be the inventor; having, divers years ſince, learned it by diſcourſing with a very ancient and experienced chymiſt, whoſe name, that I do not mention, will perhaps ſeem ſomewhat ſtrange to thoſe readers, that have obſerved me not to be backward in acknowledging my benefactors in point of experiments; and therefore I hold it not amiſs to take this opportunity of declaring once for all, that it were oftentimes more prejudicial than grateful to one, that makes an advantage by the practiſe of phyſick, to annex in his life-time his name to ſome of his receipts or proceſſes; becauſe that when a man has once got a repute for having a ſpecifick in any particular diſeaſe or caſe, his patients, and their friends will hardly

hardly forbear to apply themſelves to him for that medicine, though the ſame medicine, but not known to be the ſame, ſhould be made uſe of by a ſtranger, or divulged in a printed book; moſt patients being not apt to rely upon medicines, that come only that way recommended; whereas if it were known, that the printed receipt is the ſelf-ſame, which the phyſician employs, not only other phyſicians would quickly make as much advantage of it as he, but many patients would think themſelves by that diſcovery diſpenſed with, in point of good huſbandry, from going to any phyſician at all, as knowing before-hand the beſt preſcription they are like to receive from him, The proceſs of the *Pilulæ lunares* is this:

The preparation of the Pilulæ lunares.

TAKE of the beſt refined ſilver as much as you pleaſe, diſſolve it into a ſufficient quantity of cleanſed ſpirit of nitre, or aqua fortis; then evaporating away the ſuperfluous moiſture, let the reſt ſhoot into thin cryſtals: theſe you may in ſome open-mouthed glaſs place in ſand, and keep in ſuch a degree of heat, that by the help of very frequently ſtirring them, the greateſt part of the more looſe and ſtinking ſpirits of the menſtruum may be driven away, and yet the remaining cryſtals not be brought to flow: theſe cryſtals of ſilver you muſt counterpoiſe with an equal weight of cryſtals of nitre; and firſt diſſolving each of them apart in diſtilled rain-water, you muſt afterwards mingle the ſolutions, and abſtract or ſteam away the ſuperfluous moiſture, till the remaining maſs be dry; which you muſt keep in an open glaſs, expoſed to ſuch a temperate heat of ſand, that the matter may not melt (which you muſt be very careful of) and that yet the adhering corroſive ſpirits of the menſtruum might be driven away. And to both theſe ends you muſt from time to time ſtir the maſs, that new parts of it may be expoſed to the heat, and new ones to the air, till you cannot deſcry in the remaining white powder any offenſive ſcent of the ſpirit of nitre, or of the aqua fortis. And laſtly, you muſt take the crumb of good white bread, made with a little moiſture into a ſtiff paſte, and exactly mingle with the newly mentioned magiſtery or powder as much of this paſte, as is neceſſary to give it the conſiſtence of a maſs of pills, which you may thence form at pleaſure, and preſerve in a well-ſtopped glaſs for uſe.

N. B. FIRST, the ſilver employed in this operation ought to be very pure and more exquiſitely refined, than much of that is wont to be, which here in *England* is bought for fine ſilver; for if the copper, wherewith ſilver-coins are wont to be alloyed, be not carefully ſeparated upon the cupel, it may, being turned by the acid menſtruum into a kind of vitriol, when it is taken into the body, either provoke vomits, or otherwiſe diſcompoſe it.

SECONDLY, the ſpirit of nitre, or (which in our caſe comes almoſt to one) the aqua fortis, that is uſed about this medicine, ought to be cleared, as our refiners phraſe it, before the ſilver be put in; for (as I elſewhere note) in ſalt-petre there is oftentimes an undiſcerned mixture of ſea-ſalt, whoſe ſpirit coming over in diſtillation with that of nitre, is apt to precipitate the ſilver, which the ſpirit of nitre has diſſolved. This I take to be the reaſon of that practice of the beſt refiners to purify their aqua fortis, by caſting in ſome ſmall piece of ſilver, that they may afterwards ſecurely put into it greater quantities of the ſame metal to be diſſolved. For the ſaline ſpirits fall to the bottom, together with the corroded ſilver, which they precipitate as long as there is any of theſe ſaline ſpirits left in the menſtruum, which after this may be decanted clear; and though you had put a little more ſilver than needed to it, it neither does harm nor is loſt, the aqua fortis preſerving none unprecipitated, but what there were no more ſaline ſpirits to work upon; ſo that the ſuperfluous ſilver put in is already diſſolved to your hand.

THIRDLY, the dry mixture obtained from the ſolutions of cryſtals of nitre, and cryſtals of ſilver, muſt be often ſtirred and kept longer in the ſand, before all the offenſive ſpirits will be driven away, than, till experience had informed me, I did imagine.

FOURTHLY, if the cryſtals of ſilver be conſiderably blue or green, it is a ſign the ſilver was not ſufficiently purged from copper; elſe the mixture we have been ſpeaking of, will look of a white, good enough. And poſſibly it was by reaſon of the not being careful to take ſufficiently refined ſilver, and of the not knowing how to improve the cryſtals of ſilver, by the addition of thoſe of nitre, and eſpecially how to free them from the ſtinking and corroſive ſpirits of aqua fortis, that it is come to paſs, that though there being ſome chymical writers proceſſes not very unlike this, yet the cryſtals of ſilver have been cenſured and laid aſide, as not always ſafe, even by thoſe, who otherwiſe much magnify the efficacy of thoſe they uſed.

FIFTHLY, when you are about to make up this mixture with the crumb of bread into a maſs, and ſo into pills, it will not be amiſs to diſpatch that work at once; for uſually it leaves an ugly blackneſs on the fingers, that cannot under divers days be gotten off.

The doſe and uſe of theſe pills.

SIXTHLY, in taking of the pills care muſt be had, that they be ſufficiently lapped up either in a wafer wetted with milk, or the pulp of a roaſted apple, or ſome ſuch thing, that they may not touch the palate, or the throat, becauſe of the extreme and diſguſting bitterneſs, which is to be met with in the cryſtals of ſilver, and which is not the leaſt thing, that with nicer perſons does blemiſh theſe pills.

SEVENTHLY, the doſe is ſomewhat uncertain; becauſe they work much according to the conſtitution of the body, and eſpecially according as it abounds with ſerous humours: wherefore it is adviſeable to make the pills of the ſize of very ſmall peas, of which one given at bed-time is a ſufficient doſe for ſome bodies, others will require two; and in ſome we muſt aſcend to three: and if the patient be hydropical, or be otherwiſe much moleſted with ſerous humours, it is obſervable, that ſometimes one doſe will work two days, or four days, (may be five or ſix) ſucceſſively, but yet moderately

moderately and uſually, without weakening the patient, in proportion to ſuch copious evacuations.

EIGHTHLY, Beſides the dropſy, wherein we have mentioned this remedy as a ſpecifick, it often proves very available in other caſes, wherein men are troubled with ſerous humours. But the firſt diſtempers, which I heard it magnified for, were thoſe of the head, and *Genus nervoſum*; and a great virtuoſo of my acquaintance, that inherits a diſpoſition to the palſy, has ſeveral times told me, that if when he begins to find himſelf diſordered, he takes a doſe of theſe pills, he is thereby conſtantly relieved. But of the particular caſes, wherein we have had opportunity to take notice of their effects, we have not now, but may perchance another time, have leiſure to entertain you.

LASTLY, That ſkilful and ſucceſsful chymiſt Dr. *N. N.* who doth much both uſe and eſteem this remedy, being deſired by me to let me know, if he had any objections againſt it, informs me, that when he hath given theſe pills oftentimes, and without intervals, though they did not either ſalivate or vomit, or much weaken the patient, yet they would at laſt be attended with a kind of incipient leucophlegmatia, which he eaſily prevents by intermitting for a while the uſe of the pills, after every ſecond or third time, that he adminiſters them, and giving, when he expects it to be requiſite, ſome *Crocus Martis*, extract of juniper, or other aſtringent or hepatick medicines, to corroborate the viſcera, and preſerve their tone.

To the 498th Page.

(Where mention is made of the cure of one, concluded to have a gangrene, by an inward medicine.)

THE cure mentioned in this place having been performed by that medicine, which from the name of that great commander as well as virtuoſo, who was the author of it, paſſes under the name of Sir *Walter Raleigh*'s cordial, and this being but one of many remarkable (and ſome of them ſtupendous) cures, which have been wrought by it from time to time, eſpecially of late, that it hath been more uſed, I am induced to annex here the yet unpubliſhed receipt; partly, becauſe there are divers receipts, that are each pretended to be the true, magnified by their ſeveral poſſeſſors; and I had the liberty of looking it out in a receipt-book, preſerved by the author's ſon; and partly becauſe, though I will not affirm, that a ſkilfuller or more promiſing compoſition of the ſame ingredients could not have been deviſed, yet the following receipt has been abundantly recommended by experience. And I remember, that but a while ſince a perſon of note having ſent to me, to deſire a taking of this cordial for a certain knight, who, after all that ſkilful phyſicians could do, had long lain a dying; I the other day chanced to meet this knight at *White-Hall*, well, lively, and with a face, whoſe ruddineſs argued a perfect recovery, and yet he is not very far from ſeventy years of age, and had, before he grew ſo ill, long conflicted with a tedious ague, and fever, which had reduced him to that extremity, when the cordial was brought, that, as himſelf told me, he neither was ſenſible, when they gave it him, nor had known what he did, or what was done unto him, during the ſpace of ſeveral days before.

Sir Walter Raleigh's *cordial, after Sir* R. K. *his way (ſet down* verbatim, *as I the author received it.)*

TAKE burrage-flowers, roſemary-flowers, marigold-flowers, red july-flowers, roſa-ſolis, elder-flowers, of each one pottle, after they are dried in the ſhade.

TAKE alſo of ſcordium, carduus, angelica, balm, mint, marjoram, ſetwall, betony, *ana* four handfuls, after they are dried in the ſhade.

TAKE alſo of the rinds of ſaſſafras of *Virginia*, lignum aloes, *ana* four ounces beaten to powder; of kermes, cubebs, cardamoms, zedoary, *ana* one ounce; of ſaffron half an ounce; juniper-berries, tormentil-roots, round birthwort roots, of each one ounce; of gentian-roots half an ounce.

DRAW the tincture or extract of theſe with ſpirit of wine *in balneo*, and ſave all the ingredients, after you have taken out the tinctures, and burn them, and put their ſalt into their tinctures.

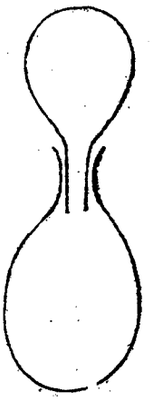
TAKE ſix ounces of the extracts of all theſe with their ſalt, and put thereto of the tincture of coral three ounces; terra ſigillata four ounces; pearl prepared two ounces; bezoar-ſtone three drachms, hartſhorn calcined four ounces, ambergreaſe four drachms, muſk *gr.* xxx; ſugar-candy one pound and an half, ground very fine, and ſearſed through a fine ſearſe.

THEN the muſk and amber muſt be ground, and by little and little mingled with it; the more you grind the amber, the better.

THEN put to the ſugar-candy all the dry materials before directed, and make all as ſmall as poſſibly you can.

THEN upon a great hollow grinding-ſtone mingle the tinctures, and dry things together, (which muſt be done by a ſtrong man uſed to that work:) and whilſt it is in grinding, put of ſyrup of lemons, and ſyrup of red roſes equal parts into it, elſe it will be ſo dry, that it will neither grind nor mingle.

How to make the tincture of Coral for this Cordial.



TAKE eight ounces of coral, and put it unbeaten into a calcining pot unluted, and let it ſtand twenty four hours in a calcining or glaſs-furnace, till the coral be as white as ſnow; then put it in three quarters of diſtilled vinegar in a long glaſs with a narrow mouth, and with another ſmall glaſs or phial put into the mouth of it, the belly upwards, to ſave the vinegar from waſting, thus; and ſet it in a ſand-furnace, ſo as the ſand may be as high as the vinegar.

LET it boil without intermiſſion twenty-four hours, by which time the vinegar will become red; ſo, when it is cold, pour off the vinegar into a glaſs-baſon, or a bell-glaſs, and vapour away

away all the vinegar *in balneo*, and gather the coral, being perfectly dry, for your uſe. You may ſtrike down your pearl with oil of vitriol, and oil of ſulphur, equal parts, which is accounted the beſt way to prepare the pearl: but Sir *R. K.* did uſe to prepare his pearl by juice of lemons.

[THE doſe for a man is about the bigneſs of a ſmall hazel-nut; but where prevention is only aimed at, or ſome ſuch uſe as the diſſipating the fumes of the ſpleen, as they call it, the bigneſs of an ordinary pea may ſuffice; ſo in urgent caſes the doſe may be increaſed to the quantity of a nutmeg. It is uſually given by it ſelf upon an empty ſtomach (the patient being kept warm after it, to promote ſweat) in fevers, want of ſpirits, violent fluxes, and ſeveral other diſtempers, where diaphoreticks and antidotes are proper, and (eſpecially) potent cordials are required.]

[To the 498th Page,
Where a receipt that cured fiſtula's is mentioned.]

A water for a fiſtula, and all manner of wounds and ſwellings, or old ulcers, cankers, tetters, boils, or ſcabs in any place, or green wounds.

TAKE of bole-armoniack four ounces, of camphire one ounce, of white vitriol four ounces; boil the camphire and the vitriol together in a little black earthen pot, till they become thin, ſtirring them together, till they become hard in ſettling; then bruiſe them in a mortar to powder, and beat the bole-armoniack it ſelf to powder, and then mingle them together, and keep the powder in a bladder, till ſuch time you uſe it. Then take a pottle of running water, and ſet it on the fire, till it begin to ſeeth; then take it from the fire, and put in three good ſpoonfuls of the powder into the water whilſt it is hot, and after put the water and powder into a glaſs, and ſhake it twice a day, to make the water ſtrong: but before you uſe it, let it be well ſettled and very clear, and apply it as hot as the patient can well ſuffer it; and lay a clean linnen cloth, four double, to the ſore, it being wet in that water, and bind it faſt with a roller to keep it warm; do it morning and evening, till it be whole. This water muſt be put into an oyſter-ſhell, not in a ſaucer, when you dreſs the ſore, for the pewter will ſuck it up. Remember you put three as good ſpoonfuls of powder as you can preſs into the ſpoon. Take heed no one drink of this water, for it is poiſon. To make it ſtronger, beat an ounce of alum to powder, and mingle it with the other powders.

TAKE of bole-armoniack half an ounce, white vitriol one ounce, of camphire two ounces, make them all into powder; then take a pottle of ſmiths-water, and as much ſpring-water, and mingling them, ſet them upon the fire. As ſoon as it begins to ſeeth, put in the powder very ſoftly, ſtirring it all the while: as ſoon as the powder is in, take it off the fire, and dreſs the wound with it twice a day, laying a cloth folded four times and wetted in the water, it being very hot, and ſo applied to the wound.

N. B. [THIS is the receipt *verbatim*, as I find it among my old papers, but I am not ſure, that among thoſe I cannot now come by, there may not be ſomething concerning a way of making a ſmall pliable tent, that may accommodate it ſelf to the crooked figure of the cavity of many fiſtula's. For methinks I remember, that the ſurgeon preſcribed the conveying the medicine by the means of ſuch a flexible tent a great way into the cavity, if not to the bottom of the fiſtula, which was thereby to be cleanſed.]

To the 507th Page.
Where ſoot is mentioned.

SOOT, *Pyrophilus*, is a production of fire, whoſe nature is almoſt as ſingular, as is the manner of its being produced; for it is (if I may ſo call it) a kind of volatile extract of the wood it proceeds from, made inſtead of a menſtruum by the fire, which haſtily diſſipating the parts of the body it acts on, hath time enough to ſever it into ſmaller particles, but not leiſure and aptitude to reduce it into ſuch differing ſubſtances, as paſs for chymical or peripatetick elements; but haſtily carries up the more volatile parts, which being not yet ſufficiently freed from the more fixed ones, take them up along with them in their ſudden flight, and ſo the aqueous, ſpirituous, ſaline, oleaginous and terreſtrial parts aſcending confuſedly together, do faſten themſelves to the ſides of the chimney in that looſe and irregular form of concretion, which we call ſoot: an inquiry into whoſe nature, as it may be conſidered in the ſurvey of the diſtinction of ſalts, muſt be elſewhere looked for; our mentioning it at preſent being only to take occaſion to tell you, that, as ill-ſcented and deſpiſed a body as it is, *Hartman*, (one of the moſt experienced and happy of chymical writers) ſcruples not to reckon the ſpirit and oil of it among the nobleſt *confortantia*; ſuch as prepared pearl, coral, amber-greeſe, and other eminent cheriſhers of nature. His preparation is for ſubſtance this: Take of the beſt ſoot, (ſuch as adheres to the lower part of the chimney, and ſhines almoſt like jet) what quantity you pleaſe, and with it fill up to the neck a very well-coated glaſs retort, or an earthen one, and luting on a capacious receiver, diſtil the matter in an open fire intended by degrees, whereby you will drive over the phlegm, the whitiſh ſpirits, and the oil, firſt of a yellow colour, and then of a red; ſeparate the phlegm, and for a while digeſt the ſpirit and the oil together, on which afterwards put half the quantity of ſpirit of wine, and diſtil them ſeveral times, whereby you will obtain, together with the ſpirit of wine, the ſpirit of ſoot, and alſo a very depurated oil, ſmelling like camphire. Out of the calcined *caput mortuum* after the common way extract a ſalt, which *Hartman* commends as a moſt excellent curer of exulcerated cancers: this ſalt, ſaith he, is drawn with vinegar, in which liquor, is a cold moiſt place; it is again diſſolved, and therewith the cancerous ulcers being once or twice anointed, the venenoſity will be viſibly drawn

Hartman's *preparation of ſpirit and oil of ſoot.*

Hartm. Prax. Chym. P. 12.

drawn out like a vapour, and then the forementioned oil being lightly ſprinkled upon the place, will breed on it a kind of cruſt like a ſkin, which ſpontaneouſly coming off in five or ſix days, will, by its falling off, argue the conſolidation of the ulcer. What this ſo extolled remedy will perform, I know not, having never made trial of it, nor thinking it very likely, that a bare alcalizate ſalt ſhould have ſuch ſpecifick virtues; nor is it requiſite I ſhould inſiſt on it, being here to diſcourſe to you of the diſtilled liquors of ſoot; in proſecution of which deſign, let me tell you, that *Hartman* preſcribes the adminiſtring of the ſpirit from ſix to ten grains, of the oil from two or three drops in wine, or any other convenient vehicle: and concerning the oil he adds, that if three drops of it be given in vinegar to an almoſt gaſping man, he will be thereby wonderfully refreſhed, and as it were revived; to which he annexeth this prognoſtick, that if the remedy produceth copious ſweats, it will recover the taker; but if not, he will die.

The author's directions concerning preparations from ſoot.

THAT this ſpirit of ſoot, deſcribed by *Hartman*, may be a very good medicine, I am very apt to think; but becauſe it is not a meer ſpirit of ſoot, but a mixed one of ſpirit of wine, and ſpirit of ſoot, we have rather choſen to proceed with the ſoot (of wood) without addition, both as to the diſtillation of it, and the ordering of the diſtilled liquors, after the manners to be mentioned ere long, when we ſhall acquaint you with our preparations of blood and hartſhorn; which if you pleaſe to apply to ſoot, you may ſave your ſelf, and me, the labour of repetitions. Yet it may not be amiſs to advertiſe you here of two things: the one, that if you employ very good and fat ſoot, and fill up the retort with it to the neck, you muſt be very careful to increaſe the fire orderly, and but by moderate degrees; or elſe you may chance to make the matter boil over out of the retort into the receiver; as it lately happened to us, when having warily ordered the fire for ſeveral hours, we thought our ſelves paſt any ſuch danger: and the other, that as to the medicinal virtues of the ſpirit, and ſalt of ſoot, I ſhall not now particularize them; partly that I may ſave time, and partly becauſe they may be well enough gathered from their affinity to the volatile ſalts and ſpirits of animal ſubſtances hereafter to be treated of; and from what I ſhall have occaſion to ſay, of the perfuming of the ſalt ſoot, towards the cloſe of this Appendix.

To the 507th Page.

Of the uſes of the preparations of urine.

URINE is a body, which, as homely and deſpiſed as it is wont to be, may, by ſkilful ways of ordering it, be made either alone, or in conjunction with other ingredients, to afford ſuch a variety of uſeful ſubſtances, that I find *Reuſnerus* publiſhed an entire treatiſe, which yet I never could get ſight of, under the title of *Synopſis remediorum ex urina præparatorum*, beſides what other chymiſts have ſince divulged on the ſame ſubject, which I forbear to mention; becauſe ſeveral of them I have not tried, and many others I think ſcarce worth trying. But becauſe even all our own obſervations, concerning the preparations and uſes of things afforded by urine, would take up more time and room, than I can now allow them, I ſhall here only take this occaſion to intimate thus much in general, that the ſpirit and ſalt of urine may be made far greater uſe of, than men yet are prone to think; not only in phyſick, but in chymiſtry, and perhaps I durſt add in natural philoſophy too. And though *Helmont* be not wont to laviſh his praiſes upon worthleſs remedies, yet he calls it *nobile ad icterum, alioſque morbos, remedium.* And in another place, ſpeaking of the ſaline cryſtals of urine, he hath this expreſſion: *Quæ quanquam ad veteres excrementorum oppilationes conferunt, nihil tamen adverſus lithiaſin*; which ſeems, by denying to the ſalt of urine ſome virtues aſcribed to it by many other chymiſts, to bring ſome credit to his praiſes of it. (And indeed a friend of mine, that has tried it in the jaundice, affirms it to deſerve the commendation he gives it in that diſeaſe.) And though I fear our author hyperbolizeth, where he (elſewhere) thus writes; *ſpernit eos ſapientia* (he means ſure that, which is proper to the Spagyriſts) *qui materiam ex qua diſpoſitiones, contenta, proprietates, progreſſum & ſignificationes lotii addiſcere recuſarent per ignem:* yet perhaps the hyperbole is not altogether ſo extravagant, as moſt readers will think it. And I remember, that a while ago, conferring with the publick miniſter of a foreign prince, who is a very inquiſitive and experienced perſon, he freely told me, that though he had travelled very much, and divers times not in a capacity, yet the greateſt chymiſt, that ever he could make acquaintance with, uſed to tell him, that ſalt of urine was ſo precious a thing, that it was a pity it ſhould be uſed in ordinary diſeaſes: but what his reaſons were for valuing it ſo much, he would not declare, and therefore I ſhall lay no great weight upon his teſtimony. And yet I muſt not at this time particularly declare, upon what account it is, that I do ſo value the volatile ſalt of urine, of whoſe virtues (whilſt it is ſingle) I ſhall only in a word obſerve to you now (what is pertinent to the occaſion of my mentioning it at preſent,) namely, that when it is well prepared [*according to the way plainly enough, though but very briefly touched already*] it differs ſo little in ſmell, taſte, volatility, penetrancy, and ſome other manifeſt qualities, from the ſalt of hartshorn, and that of man's blood; that ſuch effects, though perhaps ſomewhat leſs powerful, may be not improbably expected from it, as are produced by the other.

De Lithiaſt. c. 3. n. 3.

To the 508th Page.

Of the preparations of man's blood.

Though I have not in this place made any abſolute promiſe, of annexing any thing more particular touching the ſpirit of blood; and though I cannot now find, and I fear may have loſt thoſe of my papers concerning that ſubject, which were the leaſt unaccurate: yet, ſetting aſide former trials, a recent account brought me by a phyſician, whom I had entruſted with ſome of it, repreſents it as ſo very good a medicine,

dicine, that I am content to ſubjoin, what particulars I have lately found among my looſe papers concerning it, as I many years ago ſent them to a friend; and this I rather do, becauſe there being annexed to the proceſs divers obſervations of general import to ſuch kind of preparations, they will be the better underſtood with it, than without it, and I have not now the leiſure to new-mould them.

Thus then;

TAKE of the blood of an healthy young man, as much as you pleaſe, and whilſt it is yet warm, add to it * twice its weight of good ſpirit of wine, and incorporating them well together, ſhut them carefully up in a convenient glaſs-veſſel, wherein the matter muſt be ſet to digeſt *in balneo*, or horſe-dung, for ſix weeks, or more: then in a glaſs-head and body, placed in aſhes or ſand, draw off with a gentle heat as much liquor, as will come over without neceſſitating you to impreſs any empyreuma upon it; the remaining matter muſt be taken out, and put into a ſtrong and capacious retort, which being placed in ſand, and accommodated with a large receiver carefully luted to it, the matter therein lodged muſt be gradually preſſed with a vehement fire, which muſt at length be increaſed, till it be ſtrong enough to give the bottom of the retort a red heat. There will firſt come over (after perhaps a little phlegm) ſpirit, either accompanied or cloſely followed by a copious volatile ſalt, faſtening it ſelf to the ſides and top of the receiver; and much about the ſame time, there will alſo come over an oil or two, or more, (for I have not obſerved the oleaginous part to come conſtantly and regularly after the ſame manner.) The receiver being taken off, all that it contains may be poured together into a convenient phial, to be therein digeſted for a month, if you pleaſe; or otherwiſe without that previous digeſtion, you may waſh down the volatile ſalt adhering to the ſides of the receiver, with the ſpirit and oil well ſhaken about it, and pour all together into a large glaſs-funnel well lined with cap-paper, firſt moiſtened with ſpirit of fair water, through which the ſpirit, and as much of the volatile ſalt, as it and the phlegm can diſſolve, will paſs firſt, leaving the oil behind them in the paper, which muſt be ſeaſonably ſet aſide, or elſe the oil alſo, though more ſlowly, will paſs through the filtre. The phlegm, ſalt, and ſpirit muſt be rectified with a very gentle heat, ſo often, till the phlegm be perfectly ſeparated, and they leave no *fæces*: the oil alſo may be rectified two or three times from its own *caput mortuum* calcined, or elſe from ſalt of tartar, to deprive it of its muddineſs. The diſtempers, wherein this *arcanum* or ſpirit of man's blood is proper, are divers, but chiefly aſthma's, epilepſies, acute fevers, pleuriſies, and conſumptions. But to comply with my preſent haſte, I ſhall advertiſe you in the general, as to the uſe of this and the other remedies to be ſubſequently mentioned, that for them I muſt refer you to the particular narratives, which I ſhall ſcarce, if you ſeaſonably deſire them, refuſe you: and in the mean time, becauſe the volatile remedies are near enough of kin to each other, I ſhall add to this firſt proceſs (which is at the leaſt one of the nobleſt of them) ſome obſervations of a more general nature, that we may both of us avoid the trouble of needleſs repetitions.

OBSERVATIONS.

Obſervations touching the manner of drawing the volatile ſalts and ſpirits of ſalt and blood, and other ſubſtances belonging to the animal kingdom.

1. I IGNORE not, that there are extant in *Burgravius*, *Beguinus*, and divers other chymical authors, very pompous and promiſing proceſſes of the eſſence of man's blood; to which they aſcribe ſuch ſtupendous faculties, as I ſhould not only wonder to find true, but admire, that they can hope the reader ſhould believe them ſo. But of theſe preparations, ſome being, as that of *Burgravius* in his *Biolychnium*, very myſtical and unlikely; and others, like *Beguinus* his ♃. *E. ſanguinis humani*, exceeding laborious, and not ſo clear, I have never put myſelf to the trouble of making them; but I ſhall be very forward to acknowledge their excellency, if any man ſhall vouchſafe me an experimental conviction of it. For though I think the preparation of blood no bad one, yet I am far from daring to affirm there cannot be a better.

2. HE that intends to have any conſiderable quantity of this ſpirit and ſalt, muſt provide himſelf of a large proportion of blood, or elſe he is like to fall ſhort of his expectation; becauſe as full of ſpirits as blood is ſuppoſed to be, it yields commonly (at leaſt the beſt I have hitherto met with) no leſs than two thirds, or more, of phlegm, beſides a not deſpicable quantity of terreſtrial and unſerviceable matter.

3. IT is requiſite, both that the retort, wherein the dried blood is diſtilled, be pretty large and ſtrong, and that the fire be very carefully and gradually adminiſtred, leſt either the copious fumes break the too narrow veſſels, or the matter too haſtily urged boil over into the neck of the retort or the receiver; both which dangers this advertiſement may help you to avoid at a cheaper rate, than I, who have not been forewarned of them but by unwelcome experience.

4. THERE is a friend of mine, an excellent chymiſt, whoſe rare cures firſt gave me a value for remedies made of blood, who uſeth (as himſelf aſſureth me) to mingle with the ſpirit that other liquor, drawn over at firſt in a head and body, and twice or thrice rectified by itſelf. But that liquor conſiſting almoſt totally of the ſpirit of wine, and the not over-grateful phlegm of the blood, though there may perhaps be paſſed into it ſome of the more fugitive particles of the volatile ſalt; yet they being ſo few as ſcarce diſcernable, this liquor ſeems fitter to be made a vehicle, than an aſſociate of our ſpirit, and perhaps too is not in all caſes the moſt proper vehicle, in which it may be adminiſtred: (though

* This, if I miſ-remember not, was the proportion I employed in the exacteſt of my experiments of this kind, but it ſeems to be eſſential to the goodneſs of the remedy; the ſpirit of wine ſerving chiefly but to keep the blood from corrupting.

(though if it were not for the ſpirit of wine, I ſhould ſomewhat ſuſpect, that the phlegm, though ſo deſtitute of the more active ingredients, as to be fit to be kept ſeparated from them, may not itſelf be quite devoid of ſpecifick virtues.) But my eſteem of the artiſt I have mentioned, doth make me think it fit to acquaint you with his practice, notwithſtanding that hitherto his authority be the chief thing, that recommends it to me.

5. DIVERS ways may be propoſed of purifying this ſpirit and ſalt we are diſcourſing of, but having tried ſeveral, that, which I now uſe is this, that follows: I put the ſalt, phlegm, and ſpirit together, in one of the higheſt and ſlendereſt bodies I can get, that the phlegm might not be able to aſcend eaſily into the head, and that the volatile ſalt may be the better ſeparated. Then in a very gentle heat (I moſt uſe that of a lamp-furnace) there will aſcend pure white and volatile ſalt, adhering to the cheeks and noſe of the glaſs-head, which if I deſire by itſelf, I ſweep it away before the ſpirit begins to riſe; but moſt commonly I ſuffer the diſtillation to proceed, and the aſcending ſpirit to carry down part of the volatile ſalt into the receiver, and ſo I continue the ſame degree of heat, till there ariſe ſo weak a ſpirit, that it plainly begins to diſſolve the volatile ſalt. Then ſhifting the receiver, I reſerve the ſtrong ſpirit and volatile ſalt by themſelves, and take the ſucceeding weaker ſpirit by itſelf alſo; to which, if I pleaſe to fortify it, I add as much of the volatile ſalt, formerly reſerved, as it is able to diſſolve. In the bottom of the cucurbit or phial there will remain a phlegmatick kind of liquor, which uſually contains ſome of the ſalt or ſpirit, and ſometimes too (which is ſomewhat odd) ſome of the oleaginous part of the blood, which did not before appear to have been aſſociated with the ſpirit, and to have paſſed through the filtre with it. This nauſeous liquor may be kept by itſelf, till you have a ſufficient quantity of it, to be worth the trouble of ſevering from it the nobler parts. The ſpirit and ſalt above mentioned may be again rectified *per ſe*, with the like gentle heat as before, ſo often, till they leave behind them no fæces, nor phlegm at all. But this is requiſite to be done only when, to maſter ſome ſtubborn diſeaſe, the medicine is to be exalted either to its ſupreme, or at leaſt to ſome approaching degree of purity and efficacy; for otherwiſe ſo exquiſite a depuration is not always neceſſary.

6. As for the oleaginous part, which the fire forceth out of blood, my obſervations of it hitherto have ſo little agreed, that I dare as yet ſpeak but heſitantly concerning it. For ſometimes but one oil hath been drawn over, ſometimes two: and I remember, laſt year, a parcel of blood, that was kept in a dung-hill for many months, yielded us a blackiſh and muddy oil, a purely red one, and another of pale amber colour, which would not mingle with the darker; of each of which ſorts I yet reſerve ſome by me. This difference may poſſibly proceed partly from the previous preparation, or unpreparedneſs, of the blood, and partly from the various adminiſtration of the fire employed to diſtil it. But for the moſt part we find theſe animal ſubſtances (if the degrees of fire be orderly adminiſtred, and the heat ſufficiently intended towards the cloſe of the diſtillation) to yield a double oil; the one more light and pure, which ſwims upon the ſpirit; the other more muddy, aduſt, and ponderous, which ſinks to the bottom of it. The uſe of theſe oils hath, by reaſon of their fetidneſs, been by moſt authors abſolutely rejected; and even thoſe few, that do not altogether reject them, forbid their inward uſe, and allow them to be but externally imployed. But conſidering, *Pyrophilus*, how much of the efficacy both of plants and animals is obſerved to reſide in their oleaginous part, it ſeemed not improbable to me, that theſe oils might deſerve a better uſage, than either to be wholly thrown away, or confined to outward ſervices; and therefore having not long ſince given a friend of mine ſome pure yellow oil of mens blood, diſſolved in ſpirit of wine, to try upon a patient of his, ſick of a hectick fever (in which diſeaſe I had ſeen the ſpirit of blood very ſucceſsful) within a few days he brought me word of the unexpected recovery of his patient, to whom he adminiſtred our medicine (that I may not conceal from you that circumſtance) in *Balſamus Samech*, made with ſpirit of vinegar inſtead of ſpirit of wine; the remaining part of this yellow mingled oil I keep yet by me, to make further trials with it. And that ſuch oils may not be loſt, I have been attempting (for I am yet upon my trials) ſeveral ways to make them ſerviceable. Some of them, that are of a more pure and defecated nature, I have (which is not unworthy your noting) found capable of readily uniting with ſpirit of wine, with which they may be allayed at pleaſure: in others I have ſeparated the finer and more volatile part, by drawing them over with a very gentle heat in a retort half full of water, which will carry over the lighter part of the oil with it into the receiver, wherein the oil will ſwim upon it, and may be afterwards ſever'd from it by a ſeparating glaſs, or any other convenient way; (but I fear that this method, though it finely clarifies oils, may rob them of the beſt part of the efficacy they may perchance derive from the latent admixtion of ſomewhat of the volatile ſalt:) at the bottom of the retort there will remain a dark and thick ſubſtance, whoſe nature I have not yet had opportunity to inquire into. Out of ſome oils (drawn from unprepared materials) which would not diſſolve in ſpirit of wine, I have, by digeſtion with ſpirit of wine, drawn much of the ſcent and taſte; the ſpirit probably imbibing ſome of the finer parts of the oil, or elſe aſſociating to it ſelf ſome volatile ſalt, that yet lay lurking in it: for ſometimes I have obſerved oils, after long keeping, to let fall a volatile ſalt undiſcerned in them before. Having alſo ſometimes mingled the heavier and lighter oils of the ſame body with dephlegmated ſpirit of wine, and in a low retort drawn over what will riſe in a very gentle heat (inferiour to that of a balneum) I have found the ſpirit of wine to carry over with it ſo many of the more ſubtile and active parts of the oil, that it was more richly impregnated therewith,

therewith, than you will be apt to expect. But of what use this oleaginous spirit may be in physick, I have not yet had time to consult experience; which I hope will, ere long, teach me better ways of improving the rejected oil, we have been speaking of, than are those almost obvious ones hitherto mentioned, wherein I am very far from acquiescing; especially since I cannot but suspect, but such active parts of such concretes would be found very capable of a great improvement, if we were as skilful to give it them.

7. THE terrestrial substance, that remains after the liquors are drawn off, if the blood have been duely prepared, affords but so inconsiderable a quantity of fixed salt, that unless the caput mortuum be exceeding copious, the alkali will hardly be worth extracting: besides, that if it could be obtained in a not despicable quantity, I should, whatever is pretended, very much doubt, whether it would be endowed with very extraordinary virtues; the violence of the fire usually depriving fixed salts of the specifick qualities of their concretes: and even in the first salt of serpents themselves, I have not discerned other than the wonted properties of alkalizate salts.

8. BECAUSE you may sometimes not have the leisure to wait six weeks for the preparation of blood, and because oftentimes the occasion of using the medicines we have been describing, may be so hasty and urgent, that unless some speedy course to relieve them be taken, before the physick can be prepared, the patients will be dead; I think it not amiss, *Pyrophilus*, to advertise you, that though without any previous preparation of blood you should immediately distil it, provided an orderly gradation of heat be carefully observed, it will yield you a reddish spirit, and (besides an oil or two) a volatile salt; which being rectified, are so little inferiour, in any properties discernible by the smell or taste, to the salt and spirit of predigested blood, that it is very probable their efficacy will emulate, though not altogether equal, that of the more laboriously prepared.

9. AND because it is difficult to get the blood of healthy men, and perhaps not safe to use that of unsound persons; and because many have a strong aversion, and some an insuperable, though groundless abhorrency, from medicines made of man's blood, I have thought it not amiss to try, whether that of some other animals, prepared the same way, might not afford us as hopeful medicines. And because the blood of deer is chiefly (and perhaps not causlesly) commended by authors, we have handled it according to the foregoing process, and thereby obtained of it a spirit, and salt, and oil, whose penetrancy, and other resemblances, make us hope, that they may prove good succedanea, in the defect of those analogous remedies (drawn from human materials) which we have been treating of.

AND to this let me, *Pyrophilus*, on this occasion, annex this advertisement, that though in these papers, and what I have further written of preparations of this nature, I name not any great number of concretes, as having drawn their volatile salts and spirits, yet I have endeavoured in these discourses to give you, in the instances I insist on, so much variety of examples, that either by the processes therein set down, or by the analogy to them, you may, I suppose, be directed, with the help of a few trials, to obtain the volatile salts and spirits of most concretes, that belong to the animal kingdom, and that are capable of affording any. For by the method we prescribe, a little varied according to the exigencies of particular bodies to be distilled, we have drawn the spirits, salts, and oils of sheep's blood, eels, vipers, *&c.* the latter of which yield a salt and liquor, which in *Italy*, by divers learned men, is superlatively extolled against obstructions, foulness of the blood, and I know not how many diseases proceeding from these two general causes. And though I dare not deny, that divers of those praises may be well enough deserved by the remedies, to which they are ascribed; yet I am not apt to think them much superiour to the generality of volatile salts: and even the spirit and salt of sheep's blood it self did, by their penetrancy of taste, and fugitiveness in gentle heats, promise little less efficacy than those others so much celebrated medicines.

How to draw tinctures, as of sulphur, &c. with the saline spirits.

10. NOR is it only by being administred itself, that one of this sulphureous and subtle kind of spirits may become a good remedy, but also by its being made a menstruum to prepare other bodies: for it will extract tinctures out of several sulphureous and resinous concretes, whose finer parts, by being associated with so piercing a vehicle, may probably gain a more intimate admission into the body, and have their virtues conveyed farther than otherwise they would reach. And a learned doctor, to whom I recommended such kind of remedies, confessed to me, that by the bare extractions of appropriated vegetables themselves, with spirit of urine, he performed no small matter. But one difficulty you may meet with in drawing the tincture of minerals, and other very compact bodies, even with good spirit of urine; (for that I account to be the cheapest of these volatile menstruums, and the most easy to be obtained in good quantities.) For we have found, but with a little heat, the more fugitive particles to ascend to the upper parts of the glass, and there fasten themselves in the form of a salt; by whose recess, the debilitated liquor was disabled from drawing the tincture so powerfully as was expected: wherefore we were reduced to make our extractions in short-necked glass-eggs or phials exquisitely stopped, (which may also be placed stooping in the sand) and when we perceived much to be lodged in the necks of the vessels, by barely inverting them, the hot liquor soon reimbibed the salt, and was fit to be placed again in sand; so that, notwithstanding this difficulty, we are able by this means, in no long time, to impregnate the spirit of urine, or of hartshorn (for I do not perfectly remember, which it was) with the tincture of flowers of sulphur, which may probably prove a noble medicine in divers affections of the lungs, since in them these volatile

liquors alone have been found very effectual. And I remember, I have ſometimes made much a ſhorter, and more odd preparation (which at any time you may command) of crude ſulphur, whereby in not many hours I have, by the means of ſalts, brought over ſuch a ſulphureous liquor or tincture, as even in the receiver was of a red colour, as well as of a ſtrongly ſulphureous ſcent.

To Page 511, *&c.*
Where *Ens Veneris* is treated of.

BUT before I enter upon particulars, I think it will not be amiſs to tell you, how this preparation firſt occurred to us, becauſe by that information your happier genius may peradventure hereafter be prompted to improve this remedy, or to deviſe one more approaching to the nature and excellency of that, which we endeavoured, but with very imperfect ſucceſs, to light on, or equal, by our *Ens Veneris*. I muſt then tell you, that an induſtrious chymiſt (of our acquaintance) and I, chancing to read one day together that odd treatiſe of *Helmont*, which he calls *Butler*; when we had attentively peruſed what he delivers of the nature, as well as ſcarce credible virtues of the *lapis Butleri* he there mentions, we fell into very ſerious thoughts, what might be the matter of ſo admirable a medicine, and the hopefulleſt manner of preparing that matter. And having freely propoſed to one another our conjectures, and examined them by what is delivered by *Helmont*, concerning the preparation of *Butler*'s ſtone, or ſome emulous remedy, we at length concurred in concluding, that either the *lapis Butleri* (as our author calls it,) or at leaſt ſome medicine of an approaching efficacy, might (if *Helmont* did not miſ-inform us) be prepared by deſtroying (as far as we could by calcination) the body of copper, and then ſubliming it with ſal armoniack.

How the author firſt happened upon the preparation of Ens Veneris.

AND becauſe the body of *Venus* ſeems leſs locked up in good vitriol, than its metalline form, we concluded, that it was beſt to calcine rather the vitriol, than the copper it ſelf; and, having freed the colcothar from its ſeparable ſalts, ſo to force it up with ſal armoniack. But the perſon I diſcourſed with, ſeeming ſomewhat diffident of this proceſs, by his unwillingneſs to attempt it, I deſired, and eaſily perſuaded him, at leaſt to put himſelf to the trouble of trying it with the requiſites to the work, which I undertook to provide, being at that time unable to proſecute it my ſelf, for want of a fit furnace in the place where I then chanced to lodge. And though at firſt we did not hit upon the beſt and moſt compendious way, yet during the ſublimation, he being ſuddenly ſurprized, as both himſelf and his domeſticks two days after told me, with a fit of ſickneſs, attended with very horrid and ſeemingly peſtilential ſymptoms, was reduced to take ſome of this medicine out of the veſſels before the due time, and upon the uſe of it found, as he told me, an almoſt immediate ceſſation of thoſe dreadful ſymptoms, but not of the paleneſs they had produced. This firſt proſperous experiment emboldened us to give our remedy the title of *Primum Ens Veneris*, which, for brevity's ſake, is wont to be called *Ens Veneris*; though I am far from thinking, that it is the admirable medicine, to which *Helmont* gives that name, at leaſt, if his *Ens Veneris* did really deſerve half the praiſes by him aſcribed to it. But ſuch as ours is, I ſhall now (as time and my yet incomplete trials will permit) acquaint you with that proceſs of it, which (among ſome others) we are moſt wont to employ, as the moſt eaſy, ſimple, and genuine.

The proceſs uſed by the author for the making of Ens Veneris.

TAKE then of the beſt Hungarian, or, if you cannot procure that, of the beſt Dantzick, or other good venereal vitriol, what quantity you pleaſe; calcine it in a ſtrong fire, till it be of a dark red; dulcify it by ſuch frequent affuſions of hot water, that at length the water, that hath paſſed through it, appear full as taſteleſs, as when it was poured on it. Let this, thus exquiſitely dulcified colcothar, when it is thoroughly dry, be very diligently ground with about an equal weight of good ſal armoniack, and let this mixture be put into a glaſs retort, and either in as ſtrong a heat as can conveniently be given in ſand, or elſe in a naked fire, force up as much of it as you can to the top of the neck of the retort; and this ſublimation being ended, out of the broken retort (laying the caput mortuum aſide) take all the ſublimate, and grind it well again, that if in any part the ſal armoniack appear ſublimed by it ſelf, it may be re-incorporated with the colcothar; reſublime this mixture *per ſe* in a glaſs-retort as before, and, if you pleaſe, you may once more elevate this ſecond ſublimate, but we have not found that always needful. And for the better underſtanding of this proceſs, be pleaſed to take notice of the following particulars.

Divers particular animadverſions concerning the preparations.

FIRST, We have always preferred ſuch vitriol as abounds with copper, before our common Engliſh vitriol, about the making of which, thoſe that keep the copperas-work at *Deptford* are wont, as themſelves have upon the place informed me, to uſe good ſtore of iron to increaſe the quantity of their vitriol.

SECONDLY, If you be unwilling to loſe the phlegm, ſpirit, and oil of that vitriol, with which you deſign to make *Ens Veneris*, you may diſtil them away in an earthen retort, or one of glaſs well coated. But though it be well known, that the diſtillation of oil of vitriol requires a very intenſe and laſting fire, (ſo that unleſs you have need of the liquors, the beſt way will be without any ceremony to calcine the vitriol in a naked fire and open) yet afterwards it will be for the moſt part requiſite, farther to calcine the caput mortuum in an open veſſel. For you muſt take notice, that unleſs the vitriol be very thoroughly calcined, it will be very troubleſome for you to dulcify it; and ſometimes we have obſerved, that the caput mortuum which looked red, and ſeemed indifferently well calcined, hath been, almoſt like crude vitriol, diſſolved in the fair water, which was poured on it, to dulcify it. The weight of the calx, in reference to the vitriol of which it was made, we cannot eaſily determine; but we have ſometimes found it neceſſary to reduce the vitriol

to

to leſs, perhaps much leſs than half its weight, to make fit for dulcification.

THIRDLY, The water, that hath been poured off the firſt and ſecond time, to edulcorate the calcined vitriol, may be filtrated and ſteamed away, till it come almoſt to the conſiſtence of a ſyrup or honey, and then may be put into a cold place to ſhoot; for after this manner we have ſometimes had many very regularly figured cryſtals or grains of ſalt: I ſay ſometimes, becauſe ſometimes alſo you may find it neceſſary to abſtract all the water, to obtain the whitiſh ſalt of vitriol, which we have known uſed as a good vomit, and which *Angelus Sala*, none of the leaſt ſober of the chymical writers, doth highly extol as an excellent emetick, in his *Ternary of vomitive remedies*, where he diſcourſeth at large of the virtues of it, and the way of adminiſtring it. And of this ſalt, as chymiſts are pleaſed to call it, we have had out of calcined copperas a very great quantity, and have ſometimes obſerved it to have been almoſt as deeply coloured, as the vitriol it ſelf was before calcination.

FOURTHLY, We ſeveral times tried to ſublime dulcified colcothar with ſal armoniack, in retorts and urinals placed in ſand; but whether by reaſon of the fixedneſs of the colcothar, or becauſe the furnace we were fain to uſe, though no very bad one, was none of the beſt, we never could that way obtain any conſiderable quantity of the deſired ſublimate, and that, which did aſcend, was but of a faint colour: wherefore, unleſs you have an extraordinary good ſand-furnace, if you will make uſe of glaſs-veſſels, which is the cleaneſt way, you will find it expedient to ſublime your colcothar in coated retorts with an open fire, except you have the dexterity to ſublime in a naked fire with glaſs retorts uncoated, which we have divers times ſeen performed by heating the bottom of the retort by degrees, and then placing it upon embers, with coals round about it, but to be kindled at a diſtance from it: for if this courſe be watchfully followed, the retort will be ſo well nealed, before it be reduced to endure any intenſe degree of heat, that after a while you may ſafely lay thoroughly kindled coals, not only round about it, but upon the top of it, (which needs not to be done till towards the end of the operation) and thereby drive moſt of the ſublimate into one lump, and into the neck of the retort. And by this way you may ſublime any furnace upon a bare hearth; but if you deſire to give a more intenſe heat, you may lay firſt ſome warm aſhes in an ordinary iron pot, and having with them, and a few ſmall coals well kindled, nealed your retort, you may afterwards proſecute the ſublimation in the ſame pot, which being once throughly heated *it* ſelf by the fire, will afterwards conſiderably increaſe the heat of it.

FIFTHLY, Though it be moſt commonly requiſite to reſublime the ſublimate, that comes the firſt time up, that the ſalt and colcothar may be more exquiſitely mixed, yet as far as we can gueſs by ſome trials, it will not be expedient to reſublime it above once (or at moſt) twice. For in thoſe trials we have found the *Ens Veneris* oftner reſublimed of a paler colour, than that which was reſublimed but once. And (*N B*) perhaps, by farther ſublimations, the ſalt, inſtead of being more intimately united with the colcothar, may be almoſt totally ſever'd from it, according to what we elſewhere in other caſes declare.

SIXTHLY, Of theſe ſublimates, that, which hath the higheſt colour, ſeems to be the beſt, as being moſt enriched with the colcothar, from whence the redneſs proceeds. But at the firſt ſublimation I have often obſerved a pretty part of the ſal armoniack to come up firſt white by it ſelf, eſpecially if it had not been very diligently mixed with the colcothar. But at the ſecond ſublimation the ingredients (which we have ſometimes almoſt totally forced up without leaving a caput mortuum in the bottom of the retort) will be more accurately mixed, and the ſublimate will appear yellow, and perhaps reddiſh, of which ſort we have ſometimes had, when the operation hath been carefully managed.

SEVENTHLY, How great a proportion of the ingredients committed to ſublimation will ariſe in the form of *Ens Veneris*, we dare not preciſely define; but ſublimate amounting to the fourth part of the whole mixture, you will ſcarce, if you work ſkilfully, fail of.

EIGHTHLY, We ſometimes made a ſublimate of equal parts of pure ſal armoniack and ſalt of tartar, both of them very throughly dried, (for elſe they will be apt to yield rather a ſpirit than a ſublimate,) well ground together, and ſo ſublimed. And with this ſublimate inſtead of ſimple ſal armoniac we intended to make *Ens Veneris*, but by ſome intervening accidents and avocations we were not able to perfect the experiment, of which we nevertheleſs think it fit to give you this hint, becauſe of the great efficacy, which an excellent phyſician of my acquaintance, to whom I gave ſome of it, aſſures me he has found in it againſt obſtructions, and ſome diſtempers, that are wont to ſpring from them.

NINTHLY, When you are about to make your firſt ſublimate, you may, if you pleaſe, lute to the retort, whereinto you put the ingredients, a ſmall receiver to catch the liquor that oftentimes comes over. For that liquor, though you will very ſeldom get much of it, yet it may be worth your preſerving, by reaſon of the volatile and urinous ſalt wherewith it will ſometimes ſo abound, that it may paſs for a weak ſpirit of ſal armoniack.

TENTHLY, The caput mortuum, that remains after the firſt ſublimation, may be put into a clean glaſs, and ſet in a cellar, where it will run *per deliquium*, into a thick and high coloured liquor, very richly impregnated (as we elſewhere manifeſt on another occaſion) with the ſomewhat opened body of copper; from whence, if half thoſe praiſes be true, which even the beſt chymiſts are pleaſed to give to copper, it may be very well concluded to have derived no ſmall virtues againſt ulcers, and divers affections, which we are not here to inſiſt on.

ELEVENTHLY, We have ſometimes doubted whether or no our *Ens Veneris* did really contain

tain any thing of cupreous or colcotharine in it, partly becauſe of the fixedneſs or ſluggiſhneſs of colcothar, and of the copper therein contained; and partly becauſe, that if ſal armoniack be two or three times ſublimed by it ſelf, its flowers frequently enough will aſcend yellow, like the paler ſort of *Ens Veneris*. But firſt, that ſal armoniac is capable of carrying up even fixed and ſluggiſh bodies, ſeemed probable to us, partly upon our incorporating and ſubliming it with finely powdered corals, (from which, though but very little of it aſcended, yet ſome of that little was no leſs red, than the corals themſelves before their being beaten) and partly upon our ſubliming it from copper, both crude and calcined, ſince of either of thoſe bodies it carried up a little with it, as appeared by the blue colour of ſome parts of the ſublimates.

And ſecondly, that the reddiſhneſs of our *Ens Veneris* proceeded partly, if not altogether from the colcothar, ſeemed probable to us, not only by the taſte, and ſome other properties of it, but alſo by this, that having knowingly committed the firſt ſublimate to a fire too weak to reſublime it; and having after ſome hours taken the veſſel out of the ſand, we found that the fire, which we ſuppoſed was not ſtrong enough to carry up the whole matter, had raiſed the ſal armoniack to the upper part of the urinal in flowers, that were either white or but pale yellow; whereas the remaining part of the mixture, that lay in good quantity in the bottom of the veſſel, was of a deep red, and a fragment of it of about the bigneſs of a large pea, being caſt upon glowing coals, and nimbly blown with a pair of bellows, coloured the flame with ſomewhat greeniſh blue, like that, but more faint, which we elſewhere have obſerved to proceed from the well-opened body of copper.

But thoſe trials, I confeſs, would rather increaſe my doubts than leſſen them, becauſe in our *Ens Veneris* the colour is not blue, but reddiſh; if I did not conſider, that colcothar is a body, that conſiſts of ſome other matter beſides common copper, (as it is alſo far more difficult to reduce, though but in part, into a metal, than is vulgar calcined copper) and conſequently when corpuſcles of differing natures are by the ſal armoniack elevated together, that, which is not metalline, may, with the aſſiſtance of the fire's operation, alter the nature of what it is, and thereby produce a colour differing from blue. But to diſpatch whatever further trials ſhall inform us, touching this queſtion, whether or no any true and reducible copper do make an ingredient in our *Ens Veneris*, yet there being in colcothar other parts as well as thoſe, that by fuſion you may reduce into a pure metal, and our remedy ſeeming by its ſomniferous property to partake of them, it will not be neceſſary to the giving our medicine a right to the appellation I commonly chooſe of *Flores Colcotharis*, that in it there is ſomething of the colcothar carried up, though poſſibly the quantity be but ſmall, and not all reducible into a metalline form. But perhaps the queſtion is not worth a longer debate, it being ſufficient to excuſe the name, and recommend the thing to ſuch a perſon as you, that colcothar is employed in the making of it, and that the thing prepared is a noble medicine, and hath ſome of the great virtues aſcribed to vitriol; whether that mineral be an ingredient of it, or no.

The doſe and uſe of Ens Veneris.

The doſe of *Ens Veneris* may be very much varied: to little children we give ſometimes one, ſometimes two, and ſometimes three grains for many nights together, as we find them able, without inconvenience, to bear the operation. To perſons of ripe years we commonly adminiſter four, five or ſix grains at a time. But one, to whom we have given quantities of it to lie by him, tells us, that he hath taken to above thirty grains at once without any inconvenience. We are wont to give it in two or three ſpoonfuls of ſack, or other wine, if the conſtitution of the patient, or the nature of the diſeaſe do not forbid it; and, in ſuch caſes, we give it in any cordial liquor, that is temperate, or any other convenient vehicle.

To children it may be given in beer, or ale, or clear poſſet-drink, but not in milk. If the patient hath ſupped at a ſeaſonable hour, we commonly adminiſter it, when he is going to ſleep. It works for the moſt part by ſweat and a little by urine, but more by ſweat at the beginning, than after the body is uſed to it; yet to ſome bodies it proves ſo ſudorifick, that two grains, or leſs of it, have often made me ſweat. That it hath once proved emetick, I have heard, but never obſerved it my ſelf to provoke vomits.

As for the medical uſe of *Ens Veneris*, divers great phyſicians will perhaps think it were not deſpicable, though it were no other than oftentimes to prove a ſafe and moderately ſomniferous medicine in fevers, without having any thing in it of opium, whoſe narcotick power they find as difficult to correct, as oftentimes proves dangerous, when being not well corrected, it is adminiſtred without very great circumſpection. But—*********

To the 514, 515, 516th Pages.

[*Finding among my looſe notes, together with thoſe, that do immediately concern the preparations of ſulphur and hartſhorn (delivered in theſe pages) ſome other particulars, that may alſo ſerve, either to afford ſome light to readers leſs ſkilled in chymiſtry, or contribute ſomewhat or other towards the relief of ſome patients, I am content to let thoſe papers go together, as I long ſince addreſſed them to a friend.*]

Of hartſhorn.

Hartſhorn, *Pyrophilus*, is a heteroclite body in nature, which hath but few reſemblers in the univerſe; for it grows to a conſiderable bulk like a vegetable, and is (unlike moſt other horns of animals) at certain ſet periods of time, deciduous; and though it be of a bony ſubſtance, yet that middle part of it which differs from the reſt in colour, does (at leaſt in grown horns) much more reſemble the pith of ſome plants than the marrow of bones: and yet this plant-animal (if I may ſo call it) does, when ſkilfully expoſed to the fire, afford the ſame differing ſubſtances, with the blood, fleſh, and other part of animals. It is no wonder therefore,

therefore, if phyſicians and chymiſts have hoped to find extraordinary virtues in ſo extraordinary a ſubject, of which we ſhall paſs by the uſual preparations, as not ſo pertinent to our preſent deſign, inſinuating only in the general, that though even the more vulgar preparations, as well as that which phyſicians have been pleaſed to call philoſophical, afford us medicines not deſpicable; yet theſe are much inferiour to thoſe remedies wherewith dexterous diſtillations are capable of preſenting us. And certainly if we allow of the chymical theory, (whoſe truth in theſe papers I queſtion not) harts-horn being generally acknowledged to be endued with properties very friendly to our nature, and even thoſe ways of preparing it, wherein the nobler and more active parts are not truly freed from thoſe cumberſome ones that fetter him, and hinder them to diſplay their powerful energies, proving yet oftentimes not unavailable: the ſpirit and ſalt of harts-horn would be in more requeſt, were not men deterred from making trials of it, partly by the over-apprehended unpleaſantneſs of the ſmell, and partly by the difficulties commonly met with in its diſtillation; the latter of which determents hath ſo frighted even chymiſts from diſtilling this cordial ſubſtance, that we have very rarely ſeen any, either ſpirit or ſalt of hartſhorn, ſave what our ſelves have been induced to prepare.

Three ways of diſtilling hartſhorn. THERE are three ways propoſed by the authors I have have met with, to diſtil hartſhorn: the one in coated glaſs retorts; the other in earthen ones; and the third in *Glauber*'s ſecond philoſophical furnace.

IN the firſt of theſe ways, ſome very ſkilful diſtillers, that have often practiſed it, have ſo complained of their frequent breaking their veſſels by the copiouſneſs, and impetuoſity of the fumes, that ruſh out of the matter, when it once begins to be preſt with a conſiderable heat, that I confeſs to you ingenuouſly, *Pyrophilus*, they have hitherto frighted me from making trial of that way; though I ſee no very great reaſon why, by a ſlow and regular gradation of the fire, the miſchances incident to this way of diſtillation may not (at leaſt moſt commonly) be avoided.

To diſtil the matter we diſcourſe of in earthen retorts, is a ſafer way than the former, if the earth be cloſe and good, and have been ſufficiently baked; as we find in the right *Heſſian* retorts, wherein we have known the operation proceed very proſperouſly, though a conſiderable quantity of the matter hath been diſtilled at once; but the retorts made of earth, that is ſpongy, or any other ways unfit, or in whoſe baking fuel hath been ſpared, are commonly (as experience hath informed us) improper for this ſervice, wherein they are eaſily broken: beſides that it is much to be feared, that all retorts made of earth, except it be extraordinarily compact and baked, are apt to imbibe the more ſubtile and more penetrant parts of harts-horn, and other volatile ſubſtances diſtilled in them; which we have obſerved in ſome, wherein the matter hath tranſudated quite though the ſubſtance of the retort, and been manifeſtly diſcernable on the outſide of it.

THE third way of diſtilling harts-horn is performed by the inſtrument deſcribed by *Glauber*, in his ſecond philoſophical furnace: but neither is this way without its inconveniencies: for beſides that, if the earth whereof the veſſel to be employed is made, be not very good and well baked earth, it will be apt to crack, in ſo violent a fire, as is requiſite in this way of diſtillation, or elſe it will imbibe part of the fineſt ſpirit it ſhould tranſmit into the receiver: and beſides that it is difficult to work long this way, without letting ſome of the active part of the ſpirit eſcape between the wide orifice of the retort and the cover: beſides theſe inconveniencies, I ſay, it is to be feared, that the matter being to be caſt immediately into the veſſel, made red-hot before-hand, it will receive a ſtronger empyreuma, or impreſſion of the fire, than it would do in the ordinary way of diſtillation; wherein the fire being orderly and ſucceſſively increaſed, much of the ſpirit and ſalt comes over into the receiver, before that laſt degree of fire is adminiſtred; which is requiſite chiefly to force over the more ſluggiſh and heavy oil, which therefore (to ſpeak congruouſly to the moſt received theory of diſtillation) favours much more of the fire, and is grown almoſt infamous for its aduſtion.

BUT notwithſtanding theſe inconveniencies, *Pyrophilus*, we have found theſe retorts of *Glauber*'s not unſerviceable, when we have had occaſion to diſtil conſiderable quantities of ſuch materials, as were not ſo precious, as to make the loſs of a part of what they were to afford us, conſiderable.

AND this advertiſement may take place, eſpecially if you take along with you what we have declared, touching the ways we ſubſtitute, to avoid, as much as may be, the newly objected inconveniences. But having in other papers taken notice particularly enough of the ways we mean, I ſhall forbear to mention them in this place, though one of them may eaſily be made applicable, as experience hath aſſured us, even to ordinary retorts: for it is not difficult to apply *theſe*, the perforated receivers, which being almoſt of the ſhape of pears, open at both ends, by holes of about two or three inches diameter (according to the capacity of the veſſel) may be with great facility taken aſunder and made clean; and may, by the convenient inſertion of their extremities into one another, be eaſily luted together (in a level) two or three, or as many of them as neceſſity ſhall require: and then, provided there be applied to the remoter extremity of the laſt of them, ſome convenient veſſel open but at one end, the receivers will very ſeldom break: the fumes that come over too copiouſly to be contained in one of them, paſſing freely thence into the ſecond or the third (for we very rarely exceed three in all) which will be manifeſtly cool, and ſo, ſpeedily turn into liquor, the fumes it receives; whilſt the firſt recipient is perhaps hotter than the hand can endure: but of theſe mechanical contrivances elſewhere.

Now

Animadverſions on ſome preparations of hartſhorn of Glauber *and* Hartman.

Now whereas *Glauber* preſcribes to mingle with the diſtilled liquors of hartſhorn rectified ſpirit of wine, to waſh out the volatile ſalt, and directs the diſtilling again of both thoſe ſpirits (of wine and hartſhorn) together; his method of proceeding may be juſtly queſtioned. For firſt, dephlegmed ſpirit of wine will not ſo readily, in the way he ſuppoſeth, diſſolve the volatile ſalt of hartſhorn; and next, the ſpirit this way drawn is not a ſimple ſpirit of hartshorn, but a compounded liquor of the ſpirit of hartſhorn, and that of wine; the latter of which may poſſibly, in divers caſes, rather impair than improve the virtue of the former. For ſpirit of hartſhorn, by reaſon of its opening and reſolving, as well as cordial virtues, is ſafely and ſucceſsfully given in fevers, wherein it is not obſerved to inflame the blood; whereas ſpirit of wine in ſuch caſes is counted dangerous. And this brings into my thoughts a very queſtionable preparation of the experienced and ingenious *Hartman*, who much extols for the worms in the ſtomach, ſpirit of hartſhorn in general, but eſpecially that which he is pleaſed to call *Eſſenſificated*, (that is, as himſelf expounds it) with which its own fixed ſalt, extracted with ſome convenient water, and its volatile duly depurated, have been diſſolved and united. For firſt, the fixed ſalt of hartſhorn hath been perhaps never yet prepared by any man: and if hartſhorn doth yield a fixed ſalt (as I dare not abſolutely deny, but that out of many pounds a few grains may be extracted) it may well be doubted, whether that ſalt be endowed with ſpecifical virtues: and next, the ſpirit of hartſhorn, if it be well dephlegmed, will not (for aught I could ever find) diſſolve its own ſalt, unleſs aſſiſted by the external warmth of the ambient air. Inſomuch that I uſually keep the ſpirit and ſalt in the ſame phial, where they remain unmixed; and the ſpirit, that will diſſolve any of its own ſalt, I account not ſufficiently dephlegmed, but to have yet an aqueous alloy, whereby the ſalt is imbibed. And I remember, that having once exquiſitely rectified ſome ſpirit of hartſhorn, and cloſed it up in a phial, after divers months it let fall a conſiderable quantity of volatile ſalt; ſo far was it from being able, without the help of ſome peculiar way, to have diſſolved more, had I caſt more into it. I deny not, that the ſpirit of hartſhorn may, by the mediation of heat, be brought to take in ſome of the ſalt of the ſame body: but of what uſe this violent impregnation of the liquor can be, unleſs it be quickly adminiſtered, I do not yet underſtand; having often ſeen the ſpirit let fall again in the cold, the volatile ſalt it had diſſolved by the aſſiſtance of heat.

Tract. Chym. p. 190.

A fourth way of preparations of hartshorn, uſed by the author.

And having thus, *Pyrophilus*, laid before you the difficulties we have met with, in the above-mentioned ways of making of ſpirit of hartſhorn, propoſed by authors, (neither of which we would yet have you altogether reject) I muſt acquaint you, with our having attempted a fourth way, which when the matter to be diſtilled is not very much, I chuſe rather to practiſe than any of the other, as hitherto ſeeming more ſafe and free from inconveniences. Take then (for inſtance) two pounds of hartſhorn broken on an anvil into pieces, each of about the bigneſs of one's finger, (for if it be raſped, there is danger, that it ſhould emit its fumes too plentifully at once) and put it into a ſtrong glaſs-retort uncoated, big enough to contain at leaſt twice as much matter: ſet this in ſand, and fit to it a pretty large and ſtrong (either ſingle or double) receiver; then give a ſlow fire for three, four, or ſix hours, to ſend away firſt the phlegm, and more fugitive parts of the ſpirit. Then increaſing the fire, but warily, and gradually for divers hours, drive over the ſpirit (which is wont to drop down ſomewhat tinged) and the more volatile parts of the ſalt; and at length intend your fire till the bottom of the retort be glowing hot, and heap alſo at laſt quick coals upon the ſand round about the retort, to give, as it were, a fire of ſuppreſſion, and ſo force over the more ſluggiſh remaining parts of the ſalt, and with it the oil: all which, are to be afterwards proceeded with, according to the directions given concerning the ſpirit, ſalt, and oil of man's blood; which having been ſufficiently inſiſted on before, will not (I ſuppoſe) need to be repeated now. Only it may not be impertinent to advertiſe you, 1. That we have more than once had the bottom of the retort melted, yet not broken, the melted glaſs being ſupported by the ſubſtrated ſand. 2. That ſometimes in filtration, ſome of the thinner parts of the oil have unperceivedly paſſed through the paper with the ſpirit and ſalt, and have not been diſcovered, but by rectification; wherein I have almoſt admired to ſee the oil, with a gentle heat of a lamp, aſcend to the top of a very tall head and body: touching which circumſtance it may yet be farther inquired, whether it proceed barely from the volatileneſs of the oil it ſelf, or alſo from its being carried up by the ſalt and ſpirit, wherewith it was aſſociated. 3. That by this way of diſtillation, we uſually have out of a pound of hartſhorn between four and five ounces (ſeldom or never ſo little as four, and often nearer five) of volatile ſalt, ſpirit, oil, and phlegm; (of the laſt of which, if the hartshorn be not recent, there will be no great quantity:) and when we diſtilled two pound of the matter at a time, we found the operation to ſucceed altogether as well, and to yield us a fully proportionable quantity of liquor.

The uſe and effects of the ſpirit of ſalt of hartſhorn, and the doſe of it.

The virtues of the ſpirit and ſalt of hartshorn, which differ not much in doſe, or efficacy, are probably very great in divers diſtempers, wherein we have yet made no trial of them. For they are conſiderable in reſiſting putrefaction, comforting nature, opening obſtructions, mortifying the acidities it meets with in the blood; and, by rendering that volatile, promoting its circulation, we have known conſiderable effects of it in fevers, pleuriſies, obſtructions of the meſentery, and ſpleen; and chiefly (which perhaps you will think ſtrange) in coughs and diſtempers of the brain, and nervous parts: in ſo much that I have, by God's bleſſing, ſometimes ſtopped very violent (but not inveterate coughs) with this medicine in a few hours. And preſcribing it to one, who

was almoſt daily aſſaulted with epileptical fits, a few doſes of it did, in a pretty while at firſt, make his fits come but ſeldom, and after, not at all: but whether he be perfectly cured, not having heard of him of late, nor having had opportunity to make farther trial of the medicine in that diſeaſe, I am not certain. We preſcribed it likewiſe, not long ſince, to a perſon, who had long lain both diſtracted, and almoſt bed-rid, and was in a ſhort time ſtrangely relieved by the uſe of it, though not perfectly cured, (perhaps, becauſe the patient took but little of the medicine, we being, then, not well ſtored with it;) and on ſome, that have been by fevers rendered ſtupid, it hath had very eminent operations. But for a farther account of its virtues, I muſt refer you to the particular narratives I may, when we meet, give you by word of mouth: and till then, it may ſuffice to tell you, that it works chiefly by ſweat, (and ſomewhat by urine) without being obſerved to leave behind it ſuch heat as divers ſudorificks are wont to do: only there muſt be care not to adminiſter it, when the *primæ viæ* and paſſages are too much ſtuffed and choked up by groſs humours, leſt by agitating the blood, and putting it into a nimble motion, it occaſion greater obſtructions. The doſe is from five drops, or grains, to a drachm (ten or fifteen drops are wont to make me ſweat) in wine, *carduus benedictus* water, or any vehicle appropriated to the diſeaſe; only taking care, that nothing acid be adminiſtered with it, becauſe acid and ſulphureous ſalts mortify, and diſarm one another. *Hartman* commends it againſt the worms of the ſtomach, againſt which it may very probably be available, by reaſon of its penetrant and ſaline nature, and its enmity to putrefaction. *Glauber* writes, that the oil rectified from ſalt of tartar cures quartans, and inward wounds, and cures the pains produced by falls, convulſions, *&c.* being adminiſtered from ſix to twenty drops to a patient placed in his bed to ſweat after it: but of this my experience will not enable me to ſay any thing. And I fear, *Pyrophilus*, that I have already too long entertained you about harts-horn: and yet I fear too, that you expect that, before I forſake this ſubject, I ſhould ſay ſomething to you concerning a much controverted particular relating thereunto. The inquiry is, whether or no, when it is diſtilled, the ſalt diſpoſe itſelf, in the receiver, into the figures of hartſhorn: the affirmative is maintained by many chymiſts, and a friend of mine, who is very ſevere, and not at all credulous, having aſſured me, that he himſelf had obſerved the inſide of his receiver over-laid with ſuch figures or horns, I dare not deny, but that accidentally the particles of the volatile ſalt may ſometimes repreſent as well the ſhape of hartſhorns, as of divers other things. But for our parts, having ſeveral ways, and not unfrequently diſtilled that matter, we could never ſee the pretended ſaline hartſhorns, ſo clearly as we thought we ſaw cauſe to eſteem, that thoſe who affirmed they conſtantly ſaw them ſo diſtinctly, looked through the ſpectacles of prepoſſeſſed imagination: not to mention, that it is the uſual method of nature in ſalts to make the bigger concretions of the ſame figures with the ſmaller grains, as we obſerve in nitre, roch-allum, *&c.* And the grains of the ſalt of hartſhorn, though I have attentively enough conſidered their ſhapes, I remember not ever to have obſerved of a figure like that of the horns they came from: but it is the nature of volatile ſalts to faſten themſelves to the receiver in various figures, according as the degree of fire, that urges them up, and other concurrent circumſtances, do chance to exact; and conſonantly hereunto, we have often obſerved the volatile ſalt of the ſame hartſhorn to be very variouſly figured in the ſame receiver. And I remember, that, not long ſince, ſubliming ſome volatile ſalt of urine, it adhered to the upper part of the veſſel in figures, much liker hartſhorns, than ever I had ſeen their volatile ſalt make up: ſo that, unleſs we will merrily ſay, that the man, whoſe urine was diſtilled, had horns given him by his wife, we muſt acknowledge, that nature ſeems to give herſelf liberty to play in the configuration of volatile ſalts, and that caſualties have no unuſual influence on them; or, to ſpeak more properly, that the various degrees of fire, the differing copiouſneſs of the fumes, and many other intervening accidents, do keep thoſe configurations from being conſtantly regular. And I remember, that, a while ſince, filtering through cap-paper a tincture of glaſs of antimony, made with ſpirit of vinegar and ſpirit of wine, almoſt according to *Baſilius*; the matter, which remained in the paper (which was placed in a glaſs-funnel, and was of the ſame ſhape) did of it ſelf, when it began to grow dry, cleave into the figures of trees, whoſe trunks, greater boughs, and ſmaller branches, were, both for their ſhape and proportion, as lively repreſented as if they had been drawn by the curious pencil of ſome ſkilful painter: which paper I ſhewed to ſome perſons, that beheld it not without wonder, and, for aught I know, I am yet able to ſhew it you. Nor is this the only inſtance I could give you, if need were, if I had not trifled too long already to manifeſt at preſent, that now and then chance may make nature ſeem to emulate art.

Q. Whether in the diſtillation of hartſhorn, the ſalt diſpoſe it ſelf into the figure of the horn.

BUT as long as I have dwelt, *Pyrophilus*, on this ſubject, before I paſs to another, I muſt not forget to advertiſe you, that in caſe ſtags-horns cannot be procured for the preparation of the above-mentioned remedies, you may without much diſadvantage ſubſtitute bucks-horns in their ſtead: for almoſt all the trials we have had opportunity to make of the medicines we have been lately diſcourſing of, have been made with remedies, whereto bucks-horns afforded materials.

That bucks-horns may be ſubſtituted for ſtags-horns.

I HAD almoſt forgot, *Pyrophilus*, to tell you, that to keep the rectified ſpirit of harts-horn, blood, or the like, is more uneaſy, than any thing but trial would make one think; and yet to keep the volatile ſalt is more difficult than to preſerve the ſpirit: for more than once, when I have kept theſe fugitive animal ſalts by themſelves, they have penetrated the corks, and ſcarce left me in the well ſtopped glaſſes any foot-ſteps of their having been there, and therefore

How to keep the ſpirit and ſalt of hartſhorn.

therefore thoſe chymiſts, that are not ſtrangers to theſe ſalts, have taken much pains to no great purpoſe, to keep them from avolation: ſome of the recenteſt and ingenioufeſt are wont, that they may moderate their uncurbed wildneſs, to pour on them as much of ſome ſuch acid ſpirit, as that of ſalt of vitriol, *&c.* as will produce any manifeſt conflict with the volatile ſalt; never conſidering, that as this courſe doth indeed diveſt them of their fugacity, ſo it doth in effect diveſt them of a great part of their nature, and conſequently of their peculiar virtues. For I have elſewhere ſhewn, that the ſaline corpuſcles, obtainable by the fire from urine, being united with a ſufficient proportion of ſpirit of ſalt, will ceaſe to be what they were, and with the ſaline parts of the acid liquor, will make up a kind of ſal armoniack. But it is eaſier for me in this our caſe to ſhew, that another man's expedient is not good, than to ſubſtitute a good one; eſpecially in this place, where for ſome reaſons I muſt not ſet down the way, that I the beſt approve of: only I ſhall tell you, that my way long was (nor do I yet deſpiſe it) to preſerve volatile ſalts in their own rectified ſpirit, which ſwimming over them, kept them from the immediate contact of the air, and preſerved them ſo well, that by this means I have ſecured even ſmall parcels of the fugitive ſalt of human blood for many years.

[*BUT ſince the ſpirit and ſalt even of this ſort of horns will not, I fear, be found ſo eaſy for every man, eſpecially, if he be a novice in chymiſtry, to procure in any conſiderable quantity; and ſince the declared intent of my communicating to the reader my obſervations about theſe ſpirits of hartſhorn, blood,* &c. *was to furniſh him with ſuch chymical remedies, that men may by their eaſineſs and cheapneſs be invited to provide them, for the uſe of the poor; I preſume it will not be improper to preſent him with a* ſuccedaneum *or two, that may be eaſily enough obtained from ſal-armoniack, though theſe preparations have ſuch connexion with divers other paſſages, wherewith they were written to the perſon I here call* Pyrophilus, *that, to avoid the too much diſmembering thoſe papers, and to make theſe proceſſes the better underſtood, I muſt content my ſelf to leave out thoſe particulars, that can beſt be ſpared; hoping, that the reſt will be eaſily excuſed, at leaſt by thoſe, who know, how much ſome chymiſts themſelves have been deluded in their trials of the divulged proceſſes, divers of which are either falſe or very uncertain, and others, though they ſhould ſucceed, would give but a ſophiſtical ſpirit, much of the obtained liquor coming from the diſtillable concretes, that muſt, according to ſuch proceſſes, be mingled with the ſal-armoniack, of which I could eaſily give inſtances, even out of modern and applauded writers.*]

Of the ſpirit of ſal armoniack, and divers attempts and ways of preparing it.

THE ſpirit of ſal armoniack, *Pyrophilus*, hath ſuch wonders aſcribed to it by chymiſts, that, if I ſhould conclude theſe papers touching ſpirits of an urinous nature, without ſaying ſomething to you of that, you might think I had left the conſiderableſt of them unmentioned; but as I the rather acquaint you with the little I know of it, becauſe, though I have met with divers authors, that extol it, I have ſcarce met with any, that teaches intelligibly, and candidly, how to prepare it, which perhaps moſt of them did not know themſelves; ſo I hope you will exact an accurate account of it the leſs rigidly, becauſe I can preſent to you but little on that ſubject, beſides the few obſervations, wherewith my own curioſity has ſupplied me; having ſcarce ever (to my knowledge) ſeen any ſpirit of ſal armoniack, ſave what my own furnaces have afforded me. And therefore without preſuming to ſet down ſolemn proceſſes about a ſubject, wherein I have found a ſmall variation of circumſtances hinder the operations made on it from producing uniform effects, I ſhall content myſelf to give you as true an information, as my memory will afford me, of a few of my proceedings with this nice ſalt, and the ſucceſſes of them: only premiſing, in a word, that by ſal armoniack I here mean the factitious and venal, conſiſting of urine, ſoot, and ſea-ſalt.

AND firſt, according to the way propoſed by *Glauber* (in the ſecond part of his philoſophical furnaces) we diſtilled it out of an open retort (with a cover to clap on and take off, as occaſion requires) with a mixture of *lapis calaminaris*; and once we, that way, obtained a quantity of liquor, which ſeemed exceeding ſtrong: but before we could make any trials with it, the phial that contained it having been accidentally broken, we loſt the opportunity of ſatisfying ourſelves of the efficacy of it. And having not long ſince attempted to make ſuch a ſpirit the ſame way, there came over indeed a liquor, which ſeemed to be the ſpirit of ſal armoniack; but when we came to rectify it in a gentle heat, the greater part of it, to our wonder, coagulated in the retort, whereinto it was put to be diſtilled, into a perfect ſal armoniack, (a pretty quantity of which I keep by me) and thereby betrayed the above mentioned liquor, to have been little elſe than the ſal armoniack itſelf, forced over by the violence of the fire, without having ſuffered any ſeparation of its ingredients. Nor is it by us alone, that the proceſs ſet down by *Glauber* hath been unproſperouſly attempted; and yet perhaps it might have conſtantly enough ſucceeded with him, and the difference of the *lapis calaminaris* (in which we have obſerved much diſparity, according to the places it comes from) may have produced the complained of variety of ſucceſſes.

WE alſo attempted to diſtil a ſpirit from ſal armoniack (to pretermit divers other trials) by mixing it with equal parts of ſalt of tartar; but in this experiment we met with variety of ſucceſs: for having exquiſitely incorporated the two ſalts by the help of a little fair water, we have divers times had the upper part of the receiver (carefully luted on to a ſomewhat large retort) all candied over on the inſide with volatile ſalts of ſeveral ſhapes; and the liquor afterwards forced over hath ſometimes remained long enough in the form of a very ſubtile and penetrant ſpirit; and ſometimes again it hath in the very receiver almoſt totally coagulated it ſelf into at lump of cryſtalline ſalt: and when we had mixt the ſalt of tartar, and ſal armoniack, without any water or other

moiſture at all, our ſucceſſes have been very like thoſe above mentioned. Upon this occaſion I dare not omit acquainting you with an experiment, which yet I learnt not upon this occaſion. Take of pure ſalt of tartar, and of good ſal armoniack, equal parts (let them be both very dry, or elſe you may loſe your labour) and grind them very accurately together, though you be deterred from continuing that toil, by a very ſubtile and fetid urinous ſteam, wont to exhale from the mixture: theſe ſalts being thus exquiſitely incorporated, you muſt put them into a large glaſs retort, to which you may fit a receiver to catch a fetid liquor, that ſometimes we have obſerved to come over. Then adminiſtring by degrees a very ſtrong fire, the top and neck of the retort will be lined with a pure white ſublimate, which ſeems to partake as well (though nothing near ſo much) of the ſalt of tartar, as of the ſal armoniack and of its qualities, and yet to differ from either. And though this ſublimate be far enough from being the true volatile ſalt of tartar, ſo highly extolled by *Paracelſus* and *Helment*; yet it is no ignoble medicine in obſtructions, and ſome other diſtempers: and I remember one of the moſt expert chymiſts I know, having made trial of ſome I preſented him, told me he found ſuch effects of it, as made him divers times very preſſing and ſollicitous for more. The fetid liquor, that will come over, we have found ſometimes to be very little, and at other times much more copious, without being able to diſcern clearly, whence the diſparity proceeded; and the caput mortuum remaining in the retort, by ſolution, filtration, and coagulation, affords a pure ſalt of greater diuretical efficacy, than almoſt any I have hitherto met withal. Another way, by which we attempted to attain a ſpirit of ſal armoniack, was, by accurately mixing two parts of it with three or four of quick-lime, whoſe virtue had not been impaired by being expoſed to the air. This mixture being diſtilled in a retort, placed in ſand, with a ſtrong fire afforded us (together with ſome dry ſublimate in the neck of the retort, and, as I remember, a little volatile ſalt in the receiver) a very ſtrong and yellowiſh ſpirit, ſo exceedingly penetrant, and ſtinking, that it was not eaſy to hold one's noſe to the open mouth of the phial, wherein it was kept, without danger of being ſtruck down, or for a while diſabled to take breath, by the plenty and violence of the exhaling ſpirits. But the liquor forced over by this method, though exceeding vigorous as to its qualities, was inconſiderable as to its quantity; and therefore we now chuſe to vary a little this way of proceeding, and let the quick-lime lie abroad in the open air (but protected from all other moiſture, except that of the air) for divers days; in which time the imbibed humidity of the ambient air would in ſome degrees ſlake it, and make it ſomewhat brittler than it was before: and the lime thus prepared, being mingled with ſalt armoniack, and diſtilled in all circumſtances after the former manner, afforded us a liquor ſo copious, and yet ſo ſtrong, that we hitherto acquieſce in this way of diſtilling this wild ſalt, as the beſt we have yet met with. But note, that we uſed, towards the latter end, to increaſe the fire to that degree, by heaping up coals on the upper part of the retort, that the mixture in the retort hath been brought to flow. Note alſo, that though even the ſpirit thus drawn perſevered long in the form of a liquor, yet yeſterday coming to look upon a phial of it, which we reſerved, to try what effect time would have on it, we found, that about a fourth or fifth part of it had ſpontaneouſly coagulated it ſelf into exactly figured grains of a cryſtalline ſalt, the liquor ſwimming about it; retaining, nevertheleſs, a very ſtrange ſubtlety: which obſervation, concording with divers others, makes me apt to doubt, whether or no this ſo celebrated ſpirit of ſalt armoniack be really much, if at all, other than the reſolved ſalt of urine, and ſoot, of which that body conſiſts, ſomewhat ſubtiliated by the fire, and freed from the clogging ſociety of the ſea-ſalt, to which they were formerly aſſociated and united; though I confeſs it ſeemeth not improbable, by the great energy, which may be obſerved in this ſpirit, when it is dextrouſly drawn, that the entire concrete, and the quick-lime, may afford it ſomething, that it could not receive from either of the ingredients, whence the mixture did reſult, as we ſee in aqua regis, which diſſolves crude gold, though neither the ſalt armoniack, nor the petre, nor the vitriol alone affords, by the uſual ways, ſpirit capable of producing that effect. The great virtues, and uſes of ſalt armoniack, eſpecially in phyſick, I cannot now ſtay to treat of, but you will find them largely enough ſet down by *Glauber*; whoſe encomiums nevertheleſs muſt not be all adopted by me, who in this place mention the ſpirit of ſal armoniack but as a medicine, that is near of kin, and may ſerve for a ſuccedaneum to the ſpirits of hartſhorn, urine, blood, *&c.*

BUT although the laſt mentioned way, *Pyrophilus*, be the leaſt imperfect one we have hitherto met with, of diſtilling ſalt armoniack; yet becauſe you may ſometimes need a ſpirituous liquor impregnated with the activeſt parts of that noble concrete, when you want either retorts to diſtil in, or furnaces capable of giving ſtrong fires, I dare not omit to inform you, that we have ſometimes drawn over ſuch a liquor of ſalt armoniack after the following manner: Diſſolve pure ſalt armoniack in a ſmall quantity of fair water; then in a cucurbit put ſuch a quantity of ſtrong quick-lime powdered as may fill up a fifth or ſixth part of the veſſel, and water it very well by degrees with the former ſolution of the ſalt armoniack, and immediately clap an alembick on the cucurbit, and faſten a receiver to the alembick, cloſing the joints very accurately; and from this mixture, by the gentle heat of a bath or a lamp, you may obtain a liquor, that ſmells much like ſpirit of urine, and ſeems to be much of the ſame nature: and this volatile liquor being once or twice rectified *per ſe*, with a very mild heat grows exceeding fugitive and penetrant, and works by ſweat, and a little, perhaps, by urine.

And

And I remember, that when I firſt made it, having been induced by ſome analogical experiments, I had formerly made, to give it to one, that had a patient troubled with an extremely violent cough, I had an account quickly brought me, that he not ſlowly, but wonderfully mended upon the very firſt or ſecond doſe; and indeed the trials, that have hitherto been made of it, make me hope, that it will prove little inferiour in efficacy to the other above mentioned more coſtly ſpirits, ſcarce any of which being preparable by ſo ſafe and compendious a way, if this medicine emulate them in virtue, the eaſineſs of the preparation (wherein little time needs be ſpent, and leſs danger of breaking veſſels incurred) will much endear it to me. But, *Pyrophilus*, becauſe I would aſſiſt you to make variety of experiments about volatile ſalts, and becauſe divers trials may be more conveniently made, when the ſaline corpuſcles are in a dry form, than when they are in that of a liquor; I will take this occaſion to mention to you a way, by whoſe intervention a change on the fixed body employed about the newly mentioned experiment, hath ſometimes afforded me ſtore of volatile ſalt. This way was only to mingle exquiſitely a quantity of ſal armoniack, with about thrice its weight of ſtrong wood-aſhes. For the ſpirit, that we this way draw out of a retort placed in ſand, did quickly in the receiver coagulate into a ſalt; and this method was again experimented with like ſucceſs. And the ſalt thus made we found ſo extremely ſubtile and volatile, that it ſeemed to be much of the ſame nature with that of urine; and if it be indeed (as probably it is) only the volatile ſalt of the urine, and perhaps alſo of the ſoot, whereof the ſal armoniack conſiſts, this may paſs for a more compendious way of obtaining ſuch ſalts, than others, that are hitherto wont to be practiſed among chymiſts. But I will not undertake, that this way of obtaining rather ſalt than ſpirit ſhall conſtantly ſucceed. Yet if you find it do not, I ſhall not perchance refuſe you a better way. But if you could deviſe a method (which poſſibly is not unattainable) of bringing over into a ſpirit, not the bare urinous and fuliginous ingredients of ſal armoniack, but the whole body; it may be, you would have a menſtruum, that would make good, if not ſurpaſs even *Renanus*'s and *Glauber*'s elogies of the ſpirit of ſal armoniack.

Of preparations of ſaline and ſulphureous fetid liquors.

THE affinity betwixt volatile ſalts and ſulphurs doth, *Pyrophilus*, as well as your curioſity, invite me to acquaint you with ſome of the trials we have made about the preparation of ſulphureous fetid liquors; which I am the more inclined to do, becauſe, though I find mention made of ſome of them in chymical books, yet they are there delivered with ſo little encouragement, amongſt many other proceſſes, of which it appears not, that the preſcribers made trial, that when I had diſtilled ſome of thoſe ſulphurs, divers expert chymiſts were very deſirous to have a ſight of them, to ſatisfy themſelves, that ſuch liquors could be ſo prepared. The way of making the common balſam, or ruby of ſulphur, is too well known to need to be long inſiſted on. Only, becauſe there is ſome little variety by ſeveral in the preparation, it will not perhaps be amiſs to inform you, that we are wont to make it by mixing about three parts of oil of turpentine, with two of good flour of brimſtone, and ſetting them on a ſtrong urinal ſlightly ſtopped in an heat of ſand, only great enough to make the liquor with a little crackling noiſe (whenceſoever that proceeds) work upon the ſulphur, till it be all perfectly reſolved into a blood-red balſam, which will be performed in ſix, eight, or ten hours, according to the quantity of the ingredient to be united. This balſam, which is indeed in ſome caſes no deſpicable remedy, is by vulgar chymiſts, according to their cuſtom, very highly extolled, and ſometimes employed in diſtempers and conſtitutions, wherein, inſtead of performing the wonders by them expected, its heat doth more harm, than its drying and balſamick properties do good: but yet apparent it will be, by what we ſhall ſay anon, that by this preparation the body of the ſulphur is ſomewhat opened, and therefore (as we ſaid) in ſome caſes the ruby of ſulphur may prove no ineffectual remedy; which may probably be improved, if it be prepared by bare digeſtion in a very gentle heat, by which courſe we have proſperouſly prepared it, though not in ſo ſhort a time, when we made it not in order to ſome other medicine.

The way of making the common balſam, or ruby of ſulphur.

To volatilize the ſulphur thus reſolved, we took the balſam made the former way, in a few hours; and putting it in a retort, either with, or without fair water, which is ſuppoſed to help to carry up the ſuperfluous oil, we placed the veſſel in a ſand-furnace; and, with a gentle heat drawing off as much of the oil of turpentine, as would in that heat come over, we ſhifted the receiver, and carefully luted on the new one; and laſtly, giving fire by degrees, we forced over a liquor of a deep and darkiſh red, extremely penetrant, but of a ſmell ſo ſulphureous and diffuſive of it ſelf, that it was ſcarce to be reſtrained by corks, and was by great odds ſtronger than that of the ruby before diſtillation.

To volatilize the balſam of ſulphur.

THE like experiment we tried in a glaſs-head and body placed in ſand, and through that way likewiſe we obtained a volatile balſam of ſulphur, yet we found it too inconvenient to be equalable with the former. What long digeſtions of this liquor will do, to take away, or leſſen its empyreumatical and offenſive odour, we have not yet been by experience ſatisfied, no more than of its medical virtues; though probably, the great penetrancy of the liquor conſidered, they will not be languid.

AUTHORS alſo preſcribe the making a volatile balſam of ſulphur, by driving over, after the above-mentioned manner, a ſolution of flour of brimſtone in linſeed-oil, and this remedy they highly extol; but though it may probably prove a good medicine, yet ſince they commend it but by conjecture, and not upon experience, I ſee no great reaſon, why it ſhould be preferable to the other. For we find, that expreſſed oils are much more apt to receive an offenſive empyreuma, than oil of turpentine; which

which being much more volatile than they, requires nothing near ſo violent a heat to make it aſcend: and, unleſs it be found, that the ſulphureous particles are able to mitigate the corroſive ones, the diſtilled liquor of an expreſſed oil may prove noxious in the body. For by purpoſely (for trial's ſake) diſtilling oil-olive, by it ſelf, though not in a naked fire, we obtained a liquor of that exceeding ſharpneſs, that it would (taken inwardly) probably corrode, or fret either the ſtomach, or ſome other of the internal parts.

Penotus *his preparation of a ſulphureous balſam, with the author's advertiſements upon it.*

THERE is another way of preparing a ſulphureous balſam, to which *Penotus*, no ignoble chymiſt, aſcribes ſuch ſtupendous virtues, that though I have not yet made trial of it in diſeaſes, yet I dare not leave it altogether unmentioned; the proceſs being briefly but this: Take good balſam of ſulphur, made with ſpirit or oil of turpentine, and having freed it from its ſuperfluous oilineſs, pour on it well dephlegmed ſpirit of wine, and therewith draw, by affuſion of new ſpirit as often as need requires, a ſufficient quantity of a red tincture, which by filtration and abſtraction *in balneo* muſt be reduced to a balſamick conſiſtence. This liquor you may, if you pleaſe, by degrees of fire, drive through a retort placed in ſand, and thereby obtain a volatile balſam of very great penetrancy, and probably of no ſmall efficacy: but the trial I have made of this proceſs, gives me occaſion to advertiſe you;

1. THAT, unleſs your balſam be reduced to a ſtiff thickneſs, and almoſt to drineſs it ſelf, the operation will hardly ſucceed; we having fruitleſly digeſted for ſome months ſpirit of wine upon balſam, whoſe conſiſtence was ſomewhat too liquid.

2. THAT as ſoon as the ſpirit of wine is ſufficiently tinged, it ought to be decanted, and ſucceeded by new; leſt by too long digeſtion, inſtead of heightening its tincture, it let fall that, which it hath already acquired.

3. THAT upon a very ſlow abſtraction of moſt of the tinged ſpirit in a digeſting-furnace, we once found the remaining liquor not to be in the form of a balſam, but to conſiſt partly of ſpirit of wine, and partly of a ſeeming diſtinct oil, whereinto the ſulphureous tincture was reduced. The balſam of ſulphur thus made without diſtillation ſeems likely to be an innocenter and nobler medicine, than the common ruby of ſulphur, made with a hot and ill ſcented oil of turpentine: and by this preparation may alſo appear the truth of what we formerly ſaid, when we told you, that the body of the ſulphur was opened by ſolution in oleaginous liquors: for out of the common thickened balſam, as you may be informed by this proceſs, well rectified ſpirit of wine will, in a ſhort time, extract a blood-red tincture; whereas by long digeſtion of ſpirit of wine alone upon pure, but undiſſolved, flowers of brimſtone, we could not diſcern any change of colour in the menſtruum; though I dare not deny the poſſibility of what ſome authors affirm, who write, that ſpirit of wine very excellently dephlegmed will in time, of it ſelf, draw a tincture from flowers of ſulphur, which tincture they yet pretend not to make of a higher than a lemon-colour. And, by the way, let me tell you, that our red tincture formerly mentioned is (if it be well made) ſo ſtrong of the ſulphur, that probably it would make a very penetrant, and effectual outward remedy in aches, and divers other cold diſtempers of the nervous parts; for it hath been already found, that good ſpirit of wine alone is one of the powerfulleſt fomentations in divers caſes of that nature, (inſomuch that it hath been ſometimes found to arreſt the ſpreading mortification of gangrenes;) and therefore being ſo richly impregnated with ſulphur, which is, even without the aſſiſtance of ſo ſubtile a vehicle, very available in many diſaffections of the *genus nervoſum*, it is probable, that the ſkilful aſſociation of two ſuch active remedies may produce conſiderable effects.

* * * * * * * * * * * *

Of an excellent balſam of ſulphur, made only with oil-olive. The common way of preparing it.

TAKE of pure flowers of ſulphur one part, of the beſt oil-olive four or five parts; mix them well together in a ſtrong earthen pot, able to contain a much greater quantity of the ingredients than is to be put in it; ſet this veſſel over a moderate fire of charcoals, throughly kindled, till the oil, though ſlowly, have perfectly diſſolved all the flowers of ſulphur, which will (if you work it well) be performed in about half an hour, or an hour, (according to the quantity of your materials:) but you muſt have a great care, during the whole operation, firſt, that the oil catch not fire, whereby it would not only be loſt it ſelf, but perhaps endanger the firing of the houſe; and next, that the mixture be kept nimbly and conſtantly ſtirring from the firſt beginning of the oil's action on the ſulphur, till the ſolution be fully made; and the pot (having been taken off the fire) be grown cold again. The chief ſigns, whereby you may perceive, that you have not erred in the operations, are, firſt, if the ſulphur be perfectly diſſolved in the oil, which you muſt often try, before you take it from the fire, by taking up with the tip of a ſtick, a drop or two of the liquor yet in preparation, and letting it cool on white paper, or on your nail, whereby you may diſcern, when the ſolution is perfectly made, by the deep redneſs, and tranſparency of the liquor, and by its containing no more in it any undiſſolved flowers of the brimſtone; next, by the conſiſtency of the balſam, which ought to be neither too liquid (as you will find it, if it hath not ſtaid its due time on the fire;) nor too thick (as it is apt to become, if you remove it not ſeaſonably from the fire,) but of the conſiſtence of ſomewhat thin honey: and laſtly, by the ſmell, which ought to be ſtrong of the ſulphur, but not of the fire; for though the ſulphureous ſtink is, in this remedy, to be expected, that empyreumatical one, which proceeds from burning (and by ſkilful noſtrils may be eaſily diſcerned) is very poſſible to be avoided.

THE doſe of this balſam, when it is to be inwardly uſed, may be from two to fifteen, or twenty drops, according as the greatneſs of the diſtemper, and chiefly the ſtrength and conſtitution of the patient ſhall require and bear. It may be given upon a faſting ſtomach, either

alone, or brought to the conſiſtence of pills, or of a bolus, with powdered ſugar, liquorice, *&c.* or elſe diſſolved in any convenient vehicle, wherewith its oleaginous nature will permit it to mingle. Outwardly it may be adminiſtred either by bare inunction of the part affected, or elſe by incorporating it with any other convenient ointment, or plaiſter: after which, we are wont to preſcribe to have an application made to the part of two or three little bags filled with ſand, as warm as the patient can eaſily endure it, and ſhifted as ſoon as either of them begins to cool, that by this means, the pores being opened, the virtue of the balſam, by being made more penetrant, may reach the farther.

I HAVE been thus particular, *Pyrophilus*, in the mention of this remedy, becauſe though it ſeem but a ſlight and trivial preparation, yet experience hath given us a better opinion of it, than I fear the ſlightneſs of the preparation will as yet allow you: and indeed its virtues I am apt to think more than I have yet had occaſion to obſerve; and therefore muſt refer you to *Rulandus* his centuries, where they are often mentioned. But outwardly in ſtrains, old aches, bruiſes, and the like, it is wont to be very effectual; in the beginning of fits of the gout it hath ſeveral times (though not conſtantly) been proſperouſly applied both to Mr. *B. B.* and divers other perſons, and ſometimes it hath been found not ineffectual even in the ſciatica itſelf. And as for paralytical diſtempers, I have had by a ſkilful phyſician an account ſent me of ſcarce credible things, which it hath therein performed: to which I ſhall only add, that a while ſince I had great thanks returned me on the behalf of a fair young lady, to whom I proſperouſly preſcribed it againſt a great tumour in her neck, which was ſuppoſed to be the beginning of the king's-evil: but this tumour was recent enough, which circumſtance I think fit to ſpecify, becauſe I fear, that if the ſcrophulous tumour had been inveterate, the ſucceſs would not have been ſo good. Inwardly the chief uſe we made of it hath been in coughs, and diſtempers allied thereunto; but its balſamick nature, making it both healing and reſiſtive (if I may ſo ſpeak) of putrifaction, makes it probable, that its virtues may be more extenſive: to which purpoſe I remember, that a while ſince a friend of mine tried it with wonderful ſucceſs *in mictu ſanguinis ferè deplorato*, having firſt by a gentle heat reduced it to ſuch a conſiſtence, as allowed him to make it up into pills. But of the particular caſes, wherein our remedy hath been ſucceſsful, no more at preſent; we ſhall rather ſubjoin, that though this have been the way, which we have the oftener imployed in the making of the balſam, yet we muſt not conceal from you, that we have divers times met with accidents, which fruſtrated our endeavours and expectations. For if the fire adminiſtred be too languid, the ſolution of the ſulphur by the oil proceeds not well: and on the other ſide we have found, that not only a ſtrong heat is apt to burn the matter, or to make the oil boil over, and perhaps take fire; but even that upon a very little exceſs in the degree of heat, the oil and ſulphur would, before it could be expected, degenerate together into a heavy and viſcous lump, (almoſt of the colour of the liver of an animal;) which coagulated matter proved afterwards exceeding difficult to be by the affuſion of freſh oil diſſolved, and reduced to a due conſiſtence. Wherefore we tried to prepare this balſam, by putting the proportion of ingredients formerly mentioned into a ſtrong urinal, which we placed in ſand, and making under it no more fire than was ſufficient to make it ſlowly work upon the flowers, (which did often during their ſolution make a crackling noiſe;) we continued the operation for divers (perhaps many) hours, at the end of which, we found the ſulphur diſſolved, and the mixture reduced to a balſamick colour and conſiſtence. So that if you diſtruſt your dexterity to prepare this balſam by the former way with a naked fire, we muſt adviſe you to make uſe of this latter way, as that, which is the ſafer, though it be the longer way of proceeding. Nay, when we had leiſure enough, we did, for trial's ſake, proſperouſly attempt the ſolution of flowers of brimſtone, with common oil, by the far gentler heat of bare digeſtion, and by that means obtained a balſam perfectly free from aduſtion, but of ſomewhat too liquid a conſiſtence; which may be eaſily remedied by the mixture of powdered liquorice, ſugar, or any other ſuch convenient concrete. We muſt alſo advertiſe you, that this balſam may alſo be prepared with oil of nuts, of poppy-ſeeds, of hypericon, inſtead of oil-olive, or any other expreſſed oil, appropriated to the particular diſtemper, againſt which the phyſician intends to employ the remedy: only care muſt be had, that the ſpecifick qualities of the oil be not ſo fugitive, as to be deſtroyed by the ebullition requiſite to the making of the balſam; which if it be to be enriched with ſpecifick virtues in relation to any particular diſeaſe, may perhaps be beſt prepared by the laſt mentioned way (of digeſtion) wherein the ſubtile ſpirits, that impregnate the oil, are not in ſuch danger to be diſſipated by the fire.

Other ways of preparing this balſam.

A balſam of antimony.

THE knowing chymiſts themſelves, *Pyrophilus*, are wont ſo much (and perhaps not altogether undeſervedly) to extol the efficacy of antimony, that we were thereby invited, beſides divers preparations of it for internal uſe, to attempt the making of ſome remedies of it, that might alſo be externally applicable; and in proſecution of this deſign, we found, that by boiling four or five fingers height of good oil of turpentine upon very finely powdered antimony, put with the liquor into a ſtrong glaſs urinal, placed in ſand, the oil after ſome hours would grow exceeding high tinged; and being gently in great part abſtracted, would leave behind it a body of a balſamick conſiſtence, and a deep redneſs: which may, I preſume, be applied to reſolve, and diſcuſs hard tumours, and remedy divers other outward evils, with more effect, than the ſimple balſam of common ſulphur formerly deſcribed. And from this antimonial balſam abſtracted to a ſtiffer conſiſtence, we found, that ſpirit of wine would draw a tincture, which I likewiſe ſuppoſe might

prove a very powerful fomentation; though the ſpirit we uſed (perhaps becauſe it was not ſufficiently dephlegmated) did not in a few days attain to more than a very pale redneſs: but this tincture being ſlowly freed from the moſt part of the ſpirit of wine, became of the conſiſtence of ſomewhat liquid honey, and of a deeper colour, thereby affording us a purer balſam; which we have not yet, (being hindred by ſome accidents) attempted to bring over the helm. Nor did we here deſiſt, but by divers trials found, that the antimonial balſam, above mentioned, being put into a retort, placed in ſand, and preſſed by degrees of fire, would at length emit ſteams, which would condenſe in the neck of the rerort, and fall thence into the receiver in ſanguine drops. This volatile red balſam (eſpecially if by this volatilization the antimony have loſt its emetick property) we cannot but think endowed with more than ordinary virtues, outward and perhaps inward too; conſidering the great penetrancy of the liquor, and the energy of the mineral, with whoſe ſubtle parts it is richly impregnated, if it conſiſt not mainly of them. But we are yet in proſecution of this preparation, and therefore till we have ſeen, how far we are like to improve this remedy, we ſhall forbear any farther mention of it; eſpecially ſince we have already, in this very paper, given you, as we ſuppoſe, ſufficient proof, that we are more ſollicitous for your ſatisfaction and proficiency, than for our own reputation, (of being a ſevere critick in eſtimating of medicines;) for otherwiſe we ſhould not have been ſo indiſcreet, as to acquaint you with any preparation, of whoſe medical virtues we have not yet made much trial, whilſt we are not deſtitute of other remedies, whoſe efficacy hath been manifeſted to us by experience. But we have often obſerved, that divers uſeful chymical preparations are mentioned ſo obſcurely, and unintelligibly, by the authors, that write of them, or elſe are without any particular, or encouraging note of diſtinction mentioned amongſt a croud of other proceſſes; ſome of which have perhaps already been found to be falſe, or trivial, and others of which may be rationally enough diſtruſted, that moſt phyſicians, and chymiſts themſelves, are deterred from attempting to prepare thoſe remedies; not ſo much becauſe they ſeem unlikely to prove conſiderable, as becauſe they are afraid, that the proceſſes are falſe, or fraudulently ſet down; and conſequently, that concretes of ſuch a conſiſtence, colour, ſcent, and other obvious qualities, as are aſcribed to the remedies propoſed, are not preparable by the publiſhed directions.

Of the obſcure and cryptical way of writing of chymiſts.

And that you might ſee, *Pyrophilus*, what diſcouragements I have met with even from artiſts themſelves, to keep me from truſting to printed chymical proceſſes, I think it not amiſs to mention here a memorable paſſage of the famous and experienced *Alexander Van Suchten*, who is reported to have gotten more by the practice of chymical phyſick than any of the contemporary profeſſors of it: for he, towards the end of his book of the ſecrets of antimony (of which he clearly diſcloſeth not any in that treatiſe) gives this account of his cryptical way of writing: *Quod in hoc tractatu nullum* recipe *propoſuerim, ob id factum eſt, quod vos ſeducere nolo*; recipe *enim illa ſeducunt juniores medicos: ſed neque à* Theophraſto *ullum* recipe *ſcriptum eſt, quod ad medicinam, quin occultum ſenſum habeat, & in quo nihil vel deerit, vel abundet, & hoc non fit ſine magnis cauſis.* Wherefore I make account, that, beſides that ſuch changes of the qualities of bodies may afford much light to naturaliſts, he doth chymiſts no uſeleſs piece of ſervice, that acquaints them with the ſucceſs of the nobler ſort of proceſſes mentioned in authors, though he ſhould give them little or no account of the virtues of the remedies prepared by thoſe proceſſes. But this I hope is not altogether our caſe: for beſides that our obſervations are likely to ſave you much trouble, and perhaps ſome miſtakes, and miſadventures; beſides that, (I ſay) we have had opportunity to obſerve ſuch eminent effects of ſeveral of the volatile liquors deſcribed in theſe papers, as may juſtly give us promiſing expectations of the properties of the reſt, which are in their obvious qualities ſo near of kin to them. And this ſort of medicines having been found ſometimes to do wonders, and generally to be ſafe, (which of a few of the known operative, and not ſpecifick medicines, can be truly affirmed) I am apt to think, that he, that ſhall bring theſe remedies, in ſpite of their ill ſcent, into the good opinion of phyſicians, may make no inconſiderable number of patients beholden to him.

I SHOULD not, *Pyrophilus*, proceed to make you repent your curioſity to know my thoughts of the urinous, and ſulphureous remedies it hath hitherto made me treat of; were it not, that there yet remains ſomething to be ſaid, without which, all that hath been ſaid, will ſcarce ſignify very much towards the effectual recommending of thoſe medicines to your eſteem and practice.

Concerning the empyreuma of chymical extracts, and their offenſiveneſs, compared with the Galenical, and thoſe which are commonly uſed by the methodiſts.

FOR I do not ignore, *Pyrophilus*, that not only the generality of the Galenical phyſicians, but divers of the more eminent and judicious of the chymiſts themſelves, have been pleaſed to condemn the internal uſe of liquors, driven through a retort by the violence of fire, upon the ſcore of their being offenſively empyreumatical, and ſtinking: among which ſorts of liquors I cannot expect, that our ſpirits of blood, hartſhorn, &c. will eſcape the being reckoned. But foraſmuch as the proſperous effects I have had opportunity to ſee, of divers remedies of that nature, have given me for them rather an eſteem, than either a deteſtation or contempt; I ſuppoſe it may prove no unſeaſonable piece of juſtice to the ſpirit of blood, and the other noble, though fetid remedies I have been ſetting you down; nor no unſerviceable piece of charity to men, if in this place, and once for all, I ſpend ſome lines in endeavouring to reſcue theſe criminated medicines from the great prejudice they ſuffer under, and from a reputation, which whilſt it renders them more odious than even their ſmell can do, is likely to make men deny themſelves the benefit of them.

I MIGHT here on this occaſion call in queſtion whether not only Galeniſts, but even many chymiſts themſelves, be not ſomewhat more afraid than they need be, of what they call *Empyreuma*. But I will ſuſpend a while that queſtion, and at preſent confeſs to you, that I have ſometimes doubted whether or no that ſtink, which is generally called by the newly mentioned name, do always and neceſſarily proceed from the impreſſions of a violent fire. For to make a pure ſpirit, and ſalt of urine, there needs nothing, but to let it in a well-ſtopt veſſel putrify for a competent time (as we elſewhere teach) in a dunghil, or any reſembling warmth, (and that it ſelf, perhaps, is not neceſſary to its putrifaction;) and then to draw off an eighth or tenth part of the liquor, that firſt aſcends by the gentle heat of a bath: by which, or by the yet milder warmth of a lamp-furnace, it may be ſufficiently rectified, and brought to yield, beſides the ſpirit, good ſtore of ſalt. And ſince the ſpirit thus made differs ſo little in ſmell or taſte from thoſe of blood and hartſhorn, that moſt men's noſes are not critical enough to diſtinguiſh them, (and we have ſometimes taken pleaſure to make chymiſts themſelves to miſtake the one of thoſe liquors for the other;) it ſeems worth conſidering, whether or no the fetid and urinous taſte and ſmell, which in theſe ſpirits is ſaid to be empyreumatical, and to proceed from the aduſtion of the fire, be not the genuine taſte and odour of the ſpirituous and ſaline particles of the mixed bodies themſelves, which they would manifeſt, if they were copiouſly extricated (to ſpeak in the king's language) ſeparated from the other principles or ingredients, and aſſociated into one body, though without the violence of the fire. For to diſtil the ſpirit of putrified urine, wherein the like ſmell and taſte are eminent, there needs (as we ſaid) no greater heat than that of a lamp-furnace, or of horſe-dung, (ſince in the latter of theſe only, urine too long kept, and but negligently ſtopt, hath been obſerved to have loſt its volatile ſalt and ſpirit, before it was taken out of the horſe-dung. And ſuch a heat ſeems not great enough to impreſs an empyreuma upon ſuch a liquor: for we ſee, that moſt things diſtilled in the greater heat of a bath, are commended by phyſicians and chymiſts for their being free from empyreuma. And what activity may be acquired by the ſubtle parts of a mixed body, by the convening (if I may ſo ſpeak) of ſuch ſpirituous particles, diſengaged from thoſe other parts, which clogged or impriſoned them, without any empyreumatical impreſſion from any violent or external heat, may appear by the chymical oils of ſpices. For though they be uſually drawn by chymiſts and apothecaries, by the help of water in limbecks; and though they have by us been drawn after another manner, (which we may elſewhere teach you) with a much gentler heat (ſometimes not exceeding that of an ordinary balneum) yet theſe well-dephlegmed liquors retaining ſo well the genuine taſte and ſmell of the concretes they were drawn from, that they paſs unaccuſed of empyreuma, are ſome of them much ſtronger and hotter than the ſpirit or ſalt of man's blood, or hartſhorn. As may appear eſpecially by the oil of cinnamon, which if pure, is more penetrant and fretting, than any thing but trial could eaſily have perſuaded me. And leſt you ſhould object, that the fire doth conſiderably contribute to the ſtrength of theſe liquors, otherwiſe than by diſengaging the particles they conſiſt of from the unactive parts of the concrete, and aſſembling them together; I muſt advertiſe you, that I have obſerved little leſs heat and penetrancy, than in divers of theſe, in ſome liquors ſeparated without the aſſiſtance of diſtillation: as for inſtance, in the purer ſort of the true Peruvian balſam, and in another kind of natural balſam, almoſt of an amber colour, which belonged to an eaſtern prince (who carried it up and down with him as a jewel) whoſe domeſticks at his death ſold it, whereby I came to procure ſome of it, and found cauſe to wonder at its ſtrength both upon the tongue and in its operation. But granting, *Pyrophilus*, that the volatile remedies treated of in theſe papers may have their offenſive ſmell and taſte imputed to the fire, yet perhaps phyſicians would more ſlowly and more tenderly cenſure the remedies in queſtion for their empyreumatical ſtink, if they did but conſider, that they themſelves ſcruple not to uſe (to name thoſe among many others) ſenna and ſcammony, though the former be wont to gripe the guts, and the latter have an acrimony, heat, and mordacity ſo unkind to the bowels, that a few grains exceeded in the doſe turns it into poiſon; becauſe the ill qualities of theſe medicines may, by proper correctives, be ſomewhat mitigated; and the good they do, doth more than countervail the inconveniences, that attend the uſe of them. For the very ſame conſiderations, *Pyrophilus*, will be applicable to the excuſe of thoſe fetid medicines, for which we apologize. For though the empyreuma or impreſſion of the fire, for which they are rejected, be the quality, whoſe abſence from them were very deſireable; yet may that empyreuma by dextrous preparations be in ſome meaſure corrected, (inſomuch that I have known highly-rectified ſpirits of urine, by being digeſted for divers months in an exquiſitely ſtopt glaſs, brought to be of a ſcent, which to me ſeemed ſcarce at all ſtinking, and to others even pleaſant) and the prejudice, that may be juſtly feared from what remains, is advantagiouſly recompenſed by the benefits accruing from the efficacy of their more friendly endowments. And in effect we find, that the dogmatiſts themſelves are grown not to ſcruple the adminiſtring the ſpirit of ſalt, though extorted (if it be of the beſt) by a much greater ſtreſs of fire, than is requiſite to the diſtillation of any of the medicines we defend. And not only the famous *Riverius* (as we have elſewhere noted) extols the ſpirit of tartar, and ſoot, which are yet ſufficiently fetid and empyreumatical, but ſeveral other (and amongſt thoſe ſome of our eminent Engliſh) phyſicians frequently uſe, and commend the oil of guaiacum, forced through a retort. And no leſs do divers learned doctors eſteem, and employ the empyreumatical oil of amber;

And whether the offenſiveneſs of divers chymical medicines proceed from the violence of the fire, or the nature of the matter.

amber; though (to note ſo much by the way) that be in divers caſes far inferiour to the volatile ſalt, which (if the fire be ſkilfully adminiſtred) may at the ſame time, and by the ſame operation, be obtained. This ſalt, beſides the efficacy aſcribed to it in the convulſions of children, having been lately found by experience to be an excellent medicine againſt the epilepſies, even of well-grown perſons, being adminiſtred in the doſe of not above a ſcruple or half a drachm, in a due quantity of piony-water, or ſome other proper vehicle.

AND on this occaſion, you may alſo be pleaſed to take notice, that foliated gold is ordinarily and without ſcruple employed by phyſicians, not only to cover pills, but as a main ingredient (though how properly, I define not) of ſeveral of their richeſt cordial compoſitions extant in diſpenſatories; and yet to how great fire gold is wont to be expoſed before it be melted out of the ore (wherein it is uſually, at leaſt as far as we have obſerved, blended with other metals, and minerals) and to purify it upon the cupel, either with lead, or antimony, he, that is unacquainted with the operations of mineraliſts, and the art of refiners, will not eaſily imagine. And, *Pyrophilus*, to ſatisfy you yet farther, that the ſtrong impreſſion of fire in the medicines does not always make them ſo noxious, as they are commonly reputed; let me deſire you to take notice, that there is ſcarce any medicament more generally given, and applauded, even by methodical phyſicians, than ſteel, which is often adminiſtred in ſubſtance, made up with other ingredients, into the form either of pills, or electuaries. And yet we have wondered to ſee, what great fires, and violent blaſts of huge bellows, moved by water-engines, are uſed to melt iron firſt out of the ſtone; and if it be to be farther refined into ſteel (much of that uſed in phyſick being factitious) a new violence of the fire is requiſite. And though after all this, to make aſtringent *crocus per ſe* (which is accounted one of the beſt preparations of it) they are wont to keep *Mars* (as the chymiſts ſpeak) amidſt reverberated flames, or in ſome glaſs-man's furnace for many hours, yea ſometimes for divers days; yet this medicine is, with more ſucceſs than ſcruple, daily adminiſtered by learned phyſicians, in dyſenteries, fluxes, and other diſtempers, where aſtriction is required. And it is ſomewhat ſtrange to me, that the having been expoſed to no greater fire, than is requiſite to diſtil ſpirit of blood, or of hartſhorn, ſhould be much urged againſt thoſe medicines by thoſe, that ſcruple not to commend, and do almoſt daily, and oftentimes ſucceſsfully, preſcribe the lixiviate ſalts of plants, and particularly of wormwood, though theſe are not rightly made, but by the expoſing the concretes even to the violence of an incinerating fire. And as for the unpleaſantneſs of the ſmells of our ſpirits of blood, hartſhorn, *&c.* beſides that, to very many perſons there is no odour ſo loathſome, as that of a potion; we find, that the Galeniſts themſelves ſcruple not, in the fits of the mother, (which yet very rarely prove mortal) to repreſs (as men are wont to ſuppoſe) the unruly fumes by the ſmell of caſtoreum, aſſa fœtida, and even the empyreumatical odour of the burnt feathers of partridges: nor do they decline to uſe theſe homely, and ungrateful remedies to the patients of the tendereſt ſex, and higheſt quality; and indeed in dangerous caſes, I have known, fair ladies content to think it fitter to take down an ill-ſcented medicine, than venture the having their own bodies, in few days, reduced to worſe perfumes. And certainly we may juſtly ſay of health, as no leſs than an emperor ſaid, of the gain brought him by urine, that *it ſmells well, from what thing ſoever it comes.*

Ways of taking off the fetidneſs, from ſpirit of urine, hartſhorn, &c.

BUT, *Pyrophilus*, if your noſtrils were ſo nice, that they muſt needs be complied with, though with the hazard of impairing the virtues of the ſalts they are offended with, I could propoſe an effectual expedient to gratify them; and being now invited by ſo preſſing an occaſion, I ſhall not ſcruple to annex ſomething of it, and tell you, that if we may judge of the virtues of the ſpirit and ſalt of ſoot (which I am wont to make without addition) by their ſenſible qualities, they muſt be much of kin to thoſe of the ſpirit of hartſhorn, and of urine; (though theſe be animal ſubſtances.) And therefore having elſewhere more particularly, and by divers experiments, declared the affinity between theſe ſalts in divers regards; it will not, I preſume, be looked upon as an unuſeful or unſeaſonable hint, if I give you a ſummary, though but imperfect account, of what I remember my ſelf to have done, in order to the freeing of the volatile ſalt of ſoot, from that very offenſive ſmell, which may poſſibly make many, even of thoſe that need them; abominate thoſe medicines, how piercing and noble ſoever, which it blemiſheth. The proceſs is as followeth:

TAKE a quantity of a well-dephlegmed ſpirit of wine proportionate to the quantity of ſalt, whoſe odour you deſire to correct; into this ſpirit, drop as much oil of rhodium, or of any other odoriferous chymical oil, as will ſuffice to make the liquor as ſtrongly ſcented as you deſire it: ſhake the oil and ſpirit well together, and if they were both well made, the latter will imbibe the former, and ſometimes be thereby turned into a whitiſh ſubſtance; with which, if it ſmell not ſtrong enough of the oil, you may by agitation incorporate more oil; and if you judge the mixture too ſtrong already, you may dilute it at pleaſure, by the affuſion of more ſpirit of wine. This done, put the ſalt of ſoot into a bolt-head, or glaſs-egg, (according to the quantity, that you intend to ſublime,) furniſhed with ſomewhat a long neck or ſtem, and afterwards pouring on leiſurely your odoriferous liquor, you may with it waſh down the ſalt, that is wont to ſtick in the neck of the glaſs. After this, you muſt very carefully ſtop the veſſel with a cork, and ſtore of hard wax, if you cannot conveniently make uſe of an exacter way of colouring it. This glaſs you muſt place in a lamp-furnace, or ſome other, wherein you may give a very moderate heat, for that will ſuffice to elevate to the neck and upper part of the veſſel, the pure white ſalt of

ſoot,

ſoot, imbued (at the ſecond time, if not at the firſt) with the ſcent of the odoriferous oil, which you imployed about the preparation.

THIS experiment, *Pyrophilus*, may prove of that uſe in phyſick, that it may deſerve as well for its nobleneſs, as the watchfulneſs, which is requiſite in him that makes it, to be illuſtrated by the enſuing

OBSERVATIONS.

Obſervations concerning this method of taking off the empyreuma.

1. THEN it is requiſite, that the ſpirit of wine be very good. For that, which is not ſufficiently dephlegmed, will not readily and perfectly receive into it ſelf the odoriferous oil, wherewith it is to be performed. Nor would every chymical oil, although it were well ſcented, be fit for this preparation; for divers of them, as oil of turpentine, and oil of amber, will not ſufficiently mingle with ſpirit of wine, unleſs they be previouſly ſubtilized after a peculiar manner.

2. THE proportion betwixt the ſpirit of wine, and the oil that it is to be diſſolved in, it is not eaſy to determine; for a leſſer quantity will ſuffice of ſome oils, than of other. And the proportion of them muſt be varied, according as you would have the ſublimed ſalt to participate more or leſs of their odour, and other qualities.

3. GREAT diligence muſt be uſed in cloſing the top of the glaſs, becauſe of the great fugacity, and ſubtilty of the ſalt, whoſe avolation is to be prevented: but then much greater care is to be had, that the heat be not too ſtrong, but as equal as may be, and much inferiour to the moderate heat of an ordinary chymical balneum. For it is ſcarce credible, how eaſily this unruly ſalt will be excited either to make an eſcape at the mouth of the glaſs, or to break it in pieces. And I remember, among ſuch other accidents, which have befallen us in the preparation of this odoriferous ſalt, that having once ſet ſome of it to ſublime from a perfumed chymical oil, though we adminiſtered ſo gentle a heat, that we thought the veſſel out of all danger of being broken, or found open; yet in a ſhort time, the fugitive ſalt did with a great noiſe blow out the cork, that was waxed to the top of the veſſel, leaving in the bottom not a limpid oil, but a liquor of a red-colour, and a balſamick conſiſtence. But if the glaſs be wide enough to allow theſe fumes competent room, and if the heat be warily adminiſtred, the ſublimation may be well enough performed.

Of the medicinal quality of theſe aromatized ſalts.

OF the medicinal quality of this aromatical ſalt, *Pyrophilus*, we have not yet had opportunity to make trial; but ſome eſteem may be made of them, by calling to mind the virtues of the ſimple ſalt of ſoot, and conſidering the nature of the liquors, from which in this our preparation it hath been ſublimed. The principal, if not the only thing, that ſeems to be feared, is, that the ſalt of ſoot being it ſelf hot, and chymical oils being for the moſt part eminently ſo too, our ſalt may prove unfit for men of hot and cholerick complexions, and in ſuch diſtempers as proceed from exceſs of heat. But then it may be conſidered in the firſt place, that the ſalt of ſoot, being of an extremely aperitive, reſolving, and volatile nature, and carrying up with it in ſublimation, only the more fugitive parts of the liquor, from which it is ſublimed; it is very likely, that the heat produced by a medicine, which by reaſon of its fugacity would ſtay but a very ſhort time in the body, will not be ſo laſting as that of ordinary ſudorificks, which are nevertheleſs often adminiſtred with good ſucceſs, even in hot diſeaſes.

SECONDLY, That there are divers bodies and diſtempers, wherein remedies may be the more proper, for their being ſomewhat hot; and experience ſhews, that in dropſies (to mention no other diſeaſes) theſe volatile ſaline remedies, that ſet the blood a whirling, and powerfully promote its circulation, may prove very available.

THIRDLY, The heat, that may be feared upon the uſe of our ſalt, may be either prevented, or at leaſt moderated by the ſeaſonable uſe of ſuch cooling remedies, as may be no enemies to the operation of this ſalt, and yet no friends to the diſtemper, againſt which it is adminiſtred.

AND laſtly, ſuppoſing, that the inconveniences proceeding from this heat were not to be altogether avoided, yet the advantageous efficacy of ſo powerful and ſearching a remedy may very much outweigh that inconveniency: and therefore *Riverius*, as we formerly told you, commends the ſpirit of ſoot (though that ſeem at leaſt as hot as the ſalt) in pleuriſies; and in the ſame hot ſickneſs, we have, as we elſewhere relate, ſucceſsfully adminiſtred the ſpirit of hartſhorn, whoſe qualities are very near of kin to thoſe of ſalt of ſoot. Other inſtances of this nature you may meet with, diſperſed in other paſſages of my chymical papers: to which I muſt add, that upon the conſideration abovementioned, the methodiſts themſelves make no difficulty, in pills and other medicines, to uſe the chymical oil, either of cloves, or of nutmegs, or even of cinnamon. And ſome of our eminenteſt Engliſh doctors, as I lately noted, have not ſcrupled of late years to uſe the ſtrong and fetid chymical oils of amber and of guaiacum, (and the latter of theſe in large doſes;) whereas in our preparation, only the fineſt and moſt aromatick parts of the oils ſeem to be aſſociated with the fuliginous ſalt, ſince the oil remaining after the ſublimation has been obſerved to be thick and ropy almoſt like a ſyrup.

BUT whether or no this aromatick ſalt be a ſafe medicine in all hot bodies and diſeaſes, it ſeems very probable, that it will prove a very powerful remedy in thoſe diſtempers, for which it is proper. For firſt, whereas Spagyriſts have, with much ſtudy, but without much ſucceſs, endeavoured to make oils capable of being mixed with other liquors, by depriving them of their oleaginous form, in which *Helmont* himſelf complains, that they are offenſive, we have, by our preparation, their fineſt parts aſſociated with the penetrant and volatile ſalt: by whoſe aſſiſtance they are not only fit to communicate their virtues to liquors, but aſſiſted

to penetrate exceedingly; and perchance alſo, thereby to obtain ſuch an acceſs to the innermoſt parts of the body, as is ſeldom allowed to vegetable medicines. Secondly, we may have by this preparation one of the moſt noble and volatile ſalts of the world, not only freed from its ſtink, but imbued with the odour, and perhaps divers of the virtues, of what chymical oils we pleaſe. And ſince theſe chymical oils are by chymiſts and naturaliſts thought to contain the moſt noble and active parts of the vegetables, whence they have been diſtilled; and ſince alſo the ſalt of ſoot ſublimed from them carries up with it the fineſt parts of theſe oils, why may it not be hoped, that no ſmall number of diſtinct remedies may be afforded us by this ſingle experiment? Theſe remedies too may be the more acceptable both to phyſicians and patients, becauſe they have not in them any thing, that is mineral; and notwithſtanding their great penetrancy and efficacy, have in them nothing of corroſive, as many of the ſaline remedies preſcribed by phyſicians in their diſpenſatories. And thirdly, that the ſalt of ſoot thus ſublimed may be alſo enriched with the ſulphur or balſamick part of the ſpirit of wine, which was employed about its preparation, may appear probable enough to him, that ſhall examine, by his taſte and otherwiſe, ſuch rectified ſpirit of wine, as has had a ſufficient quantity of volatile ſalts ſublimed from it. And how balſamical a ſubſtance is diffuſed through pure ſpirit of wine, may be gueſſed at by the great change, which is made in the cauſtick ſalt of tartar, when it is ſo dulcified, as to make that excellent medicine, which *Helmont* extols againſt inward ulcers, and calls *Balſamus Samech*; which if one had the abſtruſe art of ſo preparing the ſalt and liquor, as to fit them for conjunction, might be made only by diſtilling very frequently pure ſpirit of wine from very fine ſalt of tartar. For by this means the fixed ſalt, retaining the ſulphureous ſalt or balſamick parts of the ſpirit of wine, (as may appear by the aquoſity of the liquor, that comes over the helm in this preparation) is thereby ſo deprived of its cauſtick taſte, that when it will rob no more ſpirit of wine, but ſuffer it to be drawn off as ſtrong as it was poured on, it will eaſily in a moiſt place run *per deliquium* into a liquor, not of a cauſtick, but balſamick (and, as it ſeemed to us, a pleaſant) taſte.

AND whereas, *Pyrophilus*, we have complained of the difficulty we have met with, to manage the unruly ſalt of ſoot, and keep it from breaking priſon, we muſt, to make this experiment be more practicable and uſeful, advertiſe you, that you may, if you pleaſe, inſtead of ſalt of ſoot, aromatize that of hartſhorn, or man's blood. And I might add, that a very ingenious friend of ours, Dr. *N. N.* has lately practiſed yet a more eaſy and preferable way of preparing medicines of this nature: but though I have partly tried his method, and found it to ſucceed well enough; yet ſince I had it but by communication from him, and that he makes a conſiderable advantage of it, I muſt forbear imparting it to you, till I ſhall have obtained his conſent to diſcloſe it.

I KNOW not, *Pyrophilus*, whether I ſhall need to add, that of theſe fetid remedies, which are volatile, and ſomewhat ſulphureous, as I choſe to mention to you but a few, to comply with my preſent haſte, which would not allow me to inſiſt on many: ſo in what I have delivered concerning theſe few, I have ſet down particulars the more fully and explicitely, becauſe I find the doctrine of volatile ſalts (though in my poor judgment worthy of a ſerious inquiry) perfunctorily, and indiſtinctly enough, handled by the chymical writers I have yet met with; which made me the willinger to contribute the few obſervations I could readily find, of thoſe I have had opportuuity to make about them, towards the illuſtration of ſo important a ſubject, of which having elſewhere ſpoken in relation to phyſiology (as theſe fugitive bodies belong to the commonwealth of ſalt,) I thought it might not be unacceptable to you, if I alſo conſidered them a while in relation to phyſick, and preſented you with ſome hints concerning their medical uſes.

To the 511th Page,

[*Where the author promiſes a delaration, how he would have his praiſes of medicines underſtood.*]

AND now, *Pyrophilus*, having finiſhed what I thought fit to add (at preſent) in the paſt appendix; I ſhould likewiſe put an end to the preſent exerciſe of your patience; but that this being my firſt treatiſe written to you concerning medical matters, and not being likely to be the laſt, which you will meet with among the papers deſigned you, I think it requiſite, and not unſeaſonable to declare to you here once for all, with what eyes I deſire you ſhould look upon what I have written, and ſhall write, to you concerning matters of that nature. And firſt, I muſt advertiſe you, that I am not ſo much a mountebank, as to recommend to you the remedies I mention as certain cures in the caſes, wherein they are proper. For he muſt have been extraordinarily happy, or very much unacquainted with the practice of phyſick, that has not found, that even thoſe medicines, which are moſt celebrated by the beſt authors, both Galenical and chymical, do ſometimes prove ineffectual as well as often proſperous; and the remedy preſcribed by the ſame phyſician to twenty patients ſick of the ſame diſeaſe has more than once been obſerved, though it have ſucceeded in nineteen, to fail in the twentieth. And indeed the cauſes of diſeaſes the conſtitution of patients, and the complications of diſtempers are ſo very various, intricate, and obſcure, that it is extremely difficult even for the moſt knowing and experienced phyſician, to make an accurate and conſtant experiment in the therapeutical part of phyſick; and conſequently ſuch experiments are much leſs to be expected from me, whoſe condition as well as diſabilities forbid me to make the practice of phyſick my buſineſs, and allow me only to adminiſter it occaſionally, either to my own particular acquaintance, or to ſuch poor people, as are not able to gratify phyſicians, or to ſuch as I meet with, where there are

not any: and thereby I am reduced to learn the virtues of divers of the remedies I have prepared by very few or none of my own immediate trials, but the relation of physicians, who do me the favour to administer them for me. And therefore, though I endeavour to put them into the hands of faithful as well as ingenious men; yet not being allowed to be my self a constant eye-witness of the effects they produce, I must here for all these reasons solemnly profess to you, that as I do not set down medicinal experiments with the same positiveness, that I do physiological ones, so I do not intend to venture the repute of being a faithful relater of experiments, upon the success of any medicinal receipt or process.

YET in the next place I must tell you, that you would perhaps do me but right, to think, not only that the chymical preparation of remedies are, if you understand them aright, candidly set down, though the virtues ascribed to them do not constantly upon all trials display themselves; but that I have not rashly and inconsiderately, or upon uncertain rumours, recorded the virtues of particular remedies, which may be good, though they be not infallible; it being sufficient to make a medicine deserve the title of good, that it be often (in some degree at least) successful, though now and then it prove not available; especially if it be otherways so safe and innocent, that even when it proves not prosperous, it weakens not nature, nor is otherwise noxious. And we must not, *Pyrophilus*, be so timid, as to suffer ourselves to be persuaded, that if a patient miscarry after the use of the remedies, the fault must necessarily belong to the exhibited medicine. For oftentimes nature will in spite of remedies make a metastasis of the peccant matter, and so impair the condition of the patient; and much oftner before death, the conflict of struggling nature and the conquering disease doth manifest itself in horrid and dreadful symptoms, which some envious or ignorant doctors (for the more learned are wont to be more equitable, and less partial) injuriously impute to the chymical remedy, given before the appearing of those symptoms; never considering, that the like accidents are wont to attend dangerous diseases, and dying persons, where Galenical remedies only, and no chymical ones at all, have been administred. And that divers of the most eminent, and methodical of our modern physicians scruple not to use frequently both *crocus metallorum*, *merc. dulcis*, and some other chymical remedies, and to impute the miscarriages of the patients, that use them to their diseases; though not many years since, all the frightful symptoms accompanying the dying persons, to whom they had been exhibited, were confidently imputed to those medicines. To which let me add, *Pyrophilus*, that oftentimes it may be very just to prize an empirical remedy more than a Galenical, though the methodist and the empirick have each of them, by his respective remedies, performed cures of divers patients in the same disease; partly because empirical chymists are seldom resorted to but in desperate cases, or till nature be almost spent, either by the violence of the disease, or the unprosperous operation of the medicines employed to remove it; and partly, because the methodist helps his remedies, by premising the wonted evacuations (by vomit, seige, or by phlebotomy) by varying them according to emergent circumstances, by skilfully and seasonably administring them, and by strict rules of diet; whereas the empirick oftentimes useth but a single remedy, and usually without premising general evacuations, exhibits it not to the greatest advantage in relation to him, and other circumstances, and is much more indulgent to his patient in point of diet: so that when an empirick and a rational physician do, both, in several patients, cure, for instance, the same pleurisy, the disease may be very often judged to have been removed into one of the patients chiefly by the physician, and in the other by the remedy.

Divers disadvantages of chymical and empirical physick in the way of ministration.

IN the third place, *Pyrophilus*, I must advertise you, that though I mention more chymical remedies than Galenical, yet it is not out of any partial fondness of the former, and much less from any undervaluation of the latter; but partly, because chymical processes being wont to be more unfaithfully, or obscurely, set down by authors than Galenical receipts, I thought it might save you some labour, to receive from me a frequenter account of those, than these; and partly, because in many chymical preparations, divers considerable changes being to be wrought upon the concretes to be prepared by them, there is oftentimes so much of philosophy to be learned by such processes, that the success of them may prove instructive to you, though it should acquaint you with their truth only, as they are chymical preparations, and not as they are medicinal receipts. But otherwise I love to look upon both chymical and Galenical remedies with an impartial eye, and think, that neither the former ought to be despised for the latter, nor the latter for the former: for as chymical remedies have commonly the advantages of being more durable, less clogging by their quantity, and less nauseated by patients; so Galenical remedies have, when they are of equal efficacy, the advantages of being more cheap, (at least quantity for quantity) more procurable, and sooner prepared. And such is the variety of cases arising from the variety of constitutions and distempers, that in some of them the former sort of remedies may be more proper, and in others, the latter may seem requisite; and in some also, both sorts may alternately be so useful, that neither of them can well be spared.

That chymical processes stand more in need of clear relations, than Galenical.

IN the fourth place, *Pyrophilus*, let me advertise you, that divers chymical remedies, and some specificks also, which are not chymical, have seemed upon trial less effectual than indeed they are, because they have been tried by such physicians as weaken their efficacy, by not administring them as they should. For some physicians will never exhibit a chymical remedy, till the patient's strength hath been almost tired, if not quite spent with the unprosperous use of divers others clogging and debilitating medicines. Others are so diffident of chymical remedies,

Errors in the time and dose of chymical remedies.

remedies,

remedies, that they never dare to exhibit them in a full doſe, nor by themſelves, but will blend a ſmall quantity of a chymical medicine, or a ſpecifick with other ingredients; which either conſtitute, with it, a medicine of new qualities, reſulting from that mixture, or at leaſt, much clog or enervate the activity and virtue of the chymical or ſpecifick ingredients: by which, even in ſo inconſiderable a doſe, theſe diſtruſtful doctors dare yet require, that great matters ſhould be performed. Of which injurious way of adminiſtring the remedies I recommend to you, *Pyrophilus*, I do not cauſeleſly deſire you to beware; as I may hereafter have occaſion to ſhew you, by particular inſtances, of the reaſonableneſs as well of this advertiſement, as of the others, which I either have given you, or ſhall give you, in this and other papers. And another ſort of phyſicians there is, who are of ſo deſpondent and rather partial an humour, that if a chymical remedy, or a ſpecifick, do not preſently perform the hoped-for cure though they find, that, even upon their diſadvantageous manner of adminiſtring it, it doth good, yet they will quickly deſiſt from the uſe of it; and becauſe it doth not do wonders, they will not ſcruple to affirm, that they have tried it, and found it do nothing: whereas they are wont to continue their own courſes of phyſick without diſcouragement, though it be uſually ſome weeks before the patient find any good by them, and oftentimes (as numbers of the printed obſervations of phyſicians, as well as daily experience teſtify) the patient is, by the tedious courſe of phyſick he has gone through, very little bettered, if not much impaired. Which I ſpeak, *Pyrophilus*, not with an intention to diſparage phyſicians in general, the moſt learned and ingenious of them being free enough from the partiality I here take notice of; but to keep good remedies from being diſparaged by the envious or unſkilful trials of bad adminiſters. And though indeed ſome chymiſts are ſo vain-glorious or unwary, as to promiſe, that the operation of their remedies ſhould be as well ſudden, as effectual; yet if the medicines themſelves be found available, although not ſwiftly ſo, that ſlowneſs ought to make us but condemn the boaſtings of the man, not reject the uſe of the remedies.

AND in the laſt place, *Pyrophilus*, I muſt advertiſe you, not to expect, that every one of the remedies I commend ſhould be phyſick and phyſician too: I mean, that it ſhould of it ſelf ſuffice to perform the cures of thoſe diſeaſes, againſt which it is commended. For medicines are but inſtruments in the hand of the phyſician, and, though they be never ſo well edged and tempered, require a ſkilful hand to manage them: and therefore I cannot but admire and diſapprove their boldneſs, that venture upon the practice of phyſick, wherein it is ſo dangerous to commit errors, barely upon the confidence of having good receipts. For though, by converſation with eminent phyſicians, I have found the learnedeſt of them to diſagree ſo much about the nature and cauſes of diſeaſes, that I dare not deny but that he may proſperouſly practiſe phyſick, that either ignores or diſſents from the received doctrines of the ſchools concerning the cauſes of diſeaſes, and ſome other pathological particulars; yet I cannot but diſlike their boldneſs, who venture to give active phyſick, either in intricate or acute diſeaſes, without at leaſt a mediocrity of knowledge in anatomy, and ſo much knowledge of the hiſtory of diſeaſes, as may ſuffice to inform them in a competent meaſure, what are the uſual ſymptoms of ſuch a diſeaſe, what courſe nature is wont to take in dealing with the peccant matter, and what diſcernible alterations in the patient's body do commonly fore-run, and thereby fore-tell a criſis, or otherwiſe the good or bad event of the diſeaſe. To all which is to be added ſome tolerable meaſure of knowledge, not only of the *materia medica*, and the chief ways of compounding ſeveral ingredients into medicines of ſeveral forms and conſiſtencies, as circumſtances may require; but alſo of the orderly and ſeaſonable adminiſtration of the helps affordable by them. Theſe particulars, *Pyrophilus*, might eaſily be enlarged on; but having neither the leiſure nor deſign to handle them common-place like, I ſhall only give you this account of my requiring, in the profeſſed practiſer of phyſick, ſome knowledge both of the *materia medica*, and the method of compounding and adminiſtring remedies, that (excepting perhaps the *arcana majora*, as chymiſts call them) even the beſt medicines, by being unſeaſonably or proſperouſly adminiſtred, eſpecially in acute diſeaſes, where nature's motions are to be diligently watched, and ſeconded, may do a patient as much harm, as the orderly and ſkilful adminiſtration of them can do him good. And that he, that has nothing but one good receipt for a diſtemper, and knows not how to vary it by adding, omitting, or ſubſtituting other parts of the *materia medica*, as urgent occaſion ſhall require, may oftentimes find himſelf reduced either to ſuffer his patient to languiſh helpleſs, or to venture by curing him of one diſeaſe to caſt him into another. For ſometimes the patient's conſtitution makes the medicine preſcribed by the receipt unfit to be adminiſtred; and ſometimes too the diſeaſe, for which the receipt is proper, is in the patient complicated with ſome other diſtemper, which may be as much increaſed by the ſpecifick, as the other diſeaſe may be leſſened. I know, for inſtance, ſome eminent men, that are wont to cure very ſtubborn venereal diſtempers, by a chymical preparation (which ſome of themſelves have been pleaſed to diſcloſe to me) of the Indian plants, ſarſaparilla, guaiacum, *&c.* But if theſe men met with patients, ſuch as thoſe, which *Euſtachius Rudius* mentions himſelf to have often met with, who, upon the uſe of the leaſt quantity of guaiacum, though corrected with cold ingredients, were wont to be preſently affected with ſuch ſharpneſs of urine, and inflammation of the parts, to which urine relates, as hazarded their lives; they would be reduced, as well as our author confeſſeth himſelf to have been, to have recourſe to mercurial or other remedies. To which we may add, that the uſe of ſarſaparilla, and guaiacum is generally forbidden by the warier ſort

That a competent meaſure of knowledge is abſolutely neceſſary to a practiſer of phyſick.

of

of phyſicians, in thoſe patients, whoſe venereal diſtempers are complicated with heat or inflammation of the kidneys or liver. And ſometimes alſo it happens, that the very outward form of the medicine preſcribed by the receipt, is not fit, or perhaps poſſible to be adminiſtred: for, not to mention, that divers patients can retain no purgative phyſick exhibited in the form of a potion; and ſome others are as apt to vomit up, whatever is given them in the form of pills; not to inſiſt on this, I ſay, I ſhall content my ſelf, to relate to you a memorable caſe, that happened a while ſince to a phyſician of my acquaintance. He was called to a luſty young woman, who, upon an accidental but violent cold, was ſuddenly taken with ſuch a conſtriction of the parts inſervient to ſpeech and deglutition, as made her altogether unable either to ſpeak or ſwallow any thing at all: and having thus continued ſome days in ſpite of clyſters or other remedies, preſcribed by a very learned phyſician, and in ſpite of endeavours to excite vomiting, by making her hold emetick things in her mouth; the poor woman was in great danger (when my acquaintance came to her) of periſhing for hunger. What in this caſe could be expected from the beſt remedies, that muſt neceſſarily be taken in at the mouth? Wherefore the phyſician finding her yet ſtrong enough, and without fever, and yet her caſe almoſt deſperate, did as judiciouſly as luckily preſcribe a clyſter, wherein to ordinary ingredients were added (as himſelf a very few days after told me) about four ounces of the infuſion of *crocus metallorum*, with an advice, that it ſhould be kept in as long as poſſibly ſhe could; and by this medicine, nature being ſufficiently irritated, there quickly followed upon it ſome violent vomiting, and upon them a liberty both of ſwallowing and ſpeaking. [And ſince this, a young gentleman and fellow-traveller of mine had the organs of deglutition ſo ſtrangely weakened without any manifeſt cauſe, that though he were able to make me a viſit, and acquaint me with his caſe, yet he was very apprehenſive, he ſhould in a very few days be ſtarved; and being unable to ſwallow remedies, had quickly periſhed in deſpite of the *arcana majora* themſelves, had he been maſter but of ſuch of them as (like thoſe wont to be magnified by chymiſts) muſt be taken into the body; if a very happy phyſician, to whom I directed him, had not by a very efficacious and ſpecifick medicine, externally to be applied, ſeaſonably reſcued him from ſo unuſual and deſperate a caſe.] But, *Pyrophilus*, as I would not, upon the ſcore of good receipts, have the phyſician's ſkill deſpiſed, or thought uſeleſs; ſo I wiſh, that the phyſician's ſkill may not make him deſpiſe good receipts. For we have often ſeen (eſpecially in outward affections) not only empiricks and chirurgeons, but even ladies and old wives, with a lucky compoſition preſcribed by a receipt, perform more conſtant and eaſy cures of the particular diſtemper, for which that receipt is proper, than even learned phyſicians by their extemporary, though pompous and artificial preſcriptions. And the illuſtrious Lord *Verulam* (one of the moſt judicious naturaliſts, that our age can boaſt) think fit to take notice of it as a deficiency, that receipts by long experience approved are not more cloſely, and, as he ſpeaks, religiouſly adhered to, but altered upon every light occaſion. And in the ſame chapter, to anſwer the principal, as well as the moſt obvious objection in this matter, 'That, ſays he, any man induced by ſome 'ſpecious reaſon ſhould be of opinion, that it 'is the part of a learned phyſician (reſpecting 'the complexions of patients, their age, the 'ſeaſon of the year, cuſtom, and the like) rather to accommodate his medicines as occaſions ſuggeſt, than to inſiſt upon ſome certain preſcripts, is a deceivable aſſertion, and 'which attributes too little to experience, too 'much to judgment.' And a little above, he goes much farther than we pretend to do; for ſpeaking of the neglect of the uſe of particular receipts, which, as he ſpeaks, by a kind of propriety, reſpect the cure of particular diſeaſes, he adds, ſeverely enough, 'that the phyſi- Crato's
'cians have fruſtrated and taken away the fruit judgment
'of traditions, and approved experience by had herein,
'their magiſtralities, in adding, and taking out, and the au-
'and changing ingredients of receipts at their thor concurs
'pleaſure, and almoſt after the manner of a- with that
'pothecaries, putting in *quid pro quo*; com- eminent
'manding ſo preſumptuouſly over the medi- phyſician.
'cine, as the medicine can no longer command
'the diſeaſe.' Thus far our judicious author: But I will rather chuſe to expreſs to you my ſenſe on this whole ſubject of receipts, in the words of that experienced phyſician to three emperors, *Johannes Crato: De morbi natura* (ſays he) *cauſa, locoque affecto, medicus diligenter cogitet, atque in eo plus quam in certis medicamentorum mirificis formis ſitum putet. Medicinam tamen expertam cum ratione adhibitam plus valere quàm ea, quæ interdum ſubitò à doctiſſimo etiam medico magna ratione exhibita excogitatur, non dubito: atque hac in parte rationales etiam medicos empiricis cedere debere de ſententia Hippocratis ſtatuo.* Only I muſt add by way of explanation, that this ſentence is to be underſtood to expreſs my ſenſe, when the medicines uſed are not very extraordinary, but ſuch, as *Crato* employed, and hath left us in his writings: for there may poſſibly be ſuch effectual ſpecificks, and ſuch powerful and commanding remedies, that the efficacy of the medicine may (at leaſt in ſome particular diſeaſes) excuſe and repair much want of ſkill in the preſcriber. Conſil. 322.

IF the teſtimony of *Helmont* concerning the *Arcana* of *Paracelſus* be conſiderable, even in a tract (where either out of emulation or judgment, he endeavours ſomewhat to depreciate both them and their author) much greater things might be boldly affirmed of ſome *Arcana*; for *Fateor lubens* (ſays he, ſpeaking of *Paracelſus*) *me ex ejus ſcriptis profeciſſe multum, illumque potuiſſe, per remedia ad unitatis ſymbolum aſcendentia, ſanare lepram, aſthma, tabem, paralyſin, epilepſiam, calculum, hydropem, podagram, cancrum, atque ejuſmodi vulgo incurabiles morbos: attamen Paracelſum fuiſſe ignarum radicis vitæ longæ, tam ex ejus ſcriptis & medicaminibus quam ex obitu collegi, &c.* And in the ſame tract, Helmont. in Arcan. Paracelſ. pag 787. Of the greater arcana, and more univerſal medicines, the efficacy of which may compenſate for want of skill in the preſcriber. Helmont. in Arcan. Paracelſ. pag. 790.

tract, jnſt before he comes to enumerate *Paracelſus*'s *Arcana*, *Concedo*, ſaith he, *univerſales aliquot medicinas, quæ ſub uniſono naturæ longè gratiſſimo, inſenſibiliter poſt ſe vinctum educunt hoſtem, cum egregia organorum depuratione; concedo pariter appropriatas aliquot quo univerſalis amplitudinem in ſpecificis morborum directionibus æmulantur.* And among thoſe *Arcana* themſelves, that is ranked but in the ſecond place, of which he gives this character; *Sequitur dein mercurius vitæ, ſtibii proles integri, quæ omnem morbi nervum penitus abſorbet.*

And becauſe another *Arcanum* doth not ſo powerfully renovate, as that laſt mentioned, and two more; he allows to thoſe three others the precedencies of that, whereof he yet ſaith, *Quarto loco eſt mercurius diaphoreticus, melle dulcior, & ad ignem fixus, ſolis horizontis omnes proprietates habet: perficit enim quicquid medicus & chirurgus poſſint optare ſanando.* But becauſe, that any medicine ſhould be qualified to deſerve ſuch ſuperlative encomiums, may ſeem a thing fitter to be wiſhed than credited, I would not diſſuade you, till the chymiſts cures have made good their maſters brags, to be altogether of our author's mind, who ſomewhere profeſſes, *Se morbum non diſtinguere, ſi remediis* (ſure he ſpeaks of ſuch remedies, as he thought he had) *ſit ſumma bonitas.* But yet you may perchance aſcribe much more even to remedies far inferiour to the *Arcana majora*, in the caſes, wherein they are moſt proper, than many are willing to believe. Inſomuch that I have ſometimes obſerved with wonder, that an excellent perſon (whom I need not name to you) cures the rickets generally in children of ſeveral ages and complexions, without having hitherto failed (as ſhe profeſſes) in any one, by preſcribing no other remedy, than the ſingle uſe of the above deſcribed colcotharine flowers, which I preſented her with. And a couple of phyſicians alſo, to whom I recommended them, tell me, they have tried them in the ſame diſeaſe with the like ſucceſs, as this lady hath hitherto met with. And I remember, that eminently learned and experienced phyſician Dr. *G. Boat*, (of whoſe ſkill both your excellent mother and you have had good proof) ſolemnly aſſured me, as I elſewhere alſo note, that he knew a phyſician, who conſtantly cured within two or three fits all agues, whether recent or radicated, in perſons of all ages, ſexes, and complexions indiſcriminately, with one ſingle outward application to the patients wriſts; but that this envious doctor would never part with it to our friend, or any elſe, no not upon his death-bed: only Dr. *Boat* diſcovered, that ſpiders, or ſomething coming from them, were main ingredients of his *Pericardia.*

The ſum and concluſion of the point in controverſy.

AND indeed there are certain preparations and compoſitions of remedies ſo lucky, and whoſe ſucceſs doth ſo much exceed expectation, and the efficacy of common compoſitions; that the ſame phyſician, whoſe they are, may upon ſeveral occaſions preſcribe an hundred others, each of which he may think as rational as any of thoſe, which nevertheleſs ſhall be all of them much inferiour thereunto. And therefore I wonder not, that the moſt learned of the methodiſts themſelves have much valued and celebrated ſome peculiar proceſſes and receipts, as here amongſt us (to mention no others) the famous Sir *Theodore Mayerne* was wont almoſt in all obſtructions, cachexies, and hydropical diſtempers, to magnify and uſe that peculiar ſalt of ſteel of his, which he was pleaſed to call *Anima hepatis.*

AND to theſe domeſtick inſtances (which I might eaſily accumulate) of the eſteem eminent phyſicians have made of receipts, I might add very many foreign ones. Nay, *Galen* himſelf, who has ſo copiouſly treated of the *Materia medica*, and the compoſition of medicaments, though he were ſufficiently expert at drawing up receipts, doth yet in his book *de compoſitione medicamentorum*, and elſewhere, tranſcribe, and ſometimes commend (and mention his having uſed) divers of the compoſitions of ancienter phyſicians, and eſpecially magnifies *Andromachus* his treacle.

I MIGHT, *Pyrophilus*, here mind you, that we ſee, that chymiſtry, as incompleat as yet it is, has been able ſo much to improve the preparation of remedies, as to afford us ſome, which are ſo innocent as well as efficacious, that in the diſeaſes they principally reſpect, they require not, as of neceſſity, near ſo much of theorical ſkill, as others do in the adminiſter. I might likewiſe take notice, that experience alſo teacheth, eſpecially by what we ſee performed by the *Spaw*, and ſome other mineral waters, that one medicine may be ſo richly endowed, as to be more effectual againſt ſeveral differing diſeaſes, than even the better ſort of other remedies againſt any one particular diſeaſe.

I MIGHT further repreſent, as ſomething that makes yet more to my preſent purpoſe, that though every body can adviſe his ſick friends to an air, that is famouſly healthful, if there be any within a convenient diſtance from them; yet there are ſome airs ſo eminently good, and that not upon the account of any one predominant quality, that makes them oppoſite to a diſeaſe ſpringing from its contrary, but from a hidden temperature, or certain friendly effluvia, that they alone often cure variety of diſeaſes in perſons of differing ages and complexions: as navigators obſerve in the Iſle of *St. Helen*, where the Spaniards and ſome other Europeans, in their paſſage to the *Indies*, often leave without phyſicians great numbers of ſick, whom they find for the moſt part recovered at their return. And that ſometimes even the acuteſt diſeaſes may by the ſanative ſteams, that enrich the air, be cured almoſt in a trice, is aſſured by thoſe, that have lived in *Grand Cairo*, who have affirmed to me, what the learned *Proſper Alpinus*, who ſo long practiſed phyſick there, aſſures us, that upon *Nilus*'s beginning to overflow, though in the heat of ſummer, there enſueth a ſudden recovery of thoſe multitudes of perſons of differing ages, temperatures, ſexes, *&c.* which there happen at that time to lie ſick of the plague. Theſe things I ſay, *Pyrophilus*, and more I might add, to what you find diſperſed here and there in the eſſays, which this paper accompanies, towards the inferring, that we ſhould not haſtily conclude

conclude it impoſible, that there may be found ſuch medicines, as may be more than particular and ſpecifick remedies, without requiring the giver to be a great phyſician. But to draw at length to a concluſion, I ſhall rather ſum up my preſent thoughts of this matter, thus.

ORDINARY receipts without an ordinary meaſure of ſkill in phyſick are not raſhly to be relied on, eſpecially in acute diſeaſes; where, by giving medicines, otherwiſe innocent enough, to loſe the opportunities of adminiſtring proper ones, may be very prejudicial; and where ſometimes the ſeveral ſeaſons of the diſeaſes do require ſuch differing remedies, if they be but ordinary ones, that a medicine proper enough for the diſeaſe at one ſeaſon of it, may do miſchief at another. But if indeed there be noble and extraordinary *Arcana*, that work rather by ſtrengthning and reſtoring nature, and reſolving, or otherwiſe deſtroying the peccant matter they find any where in the body, than by irritating and weakening nature, or putting her as it were to a troubleſome plunge; the uſe of ſuch remedies may deſerve to be a little otherwiſe conſidered, as that, which may not ordinarily (for I ſay not ever) require more inſtruction than may be afforded to perſons not indiſcreet, by ſuch directions and cautions as may be divulged, or otherwiſe communicated, together with the remedies themſelves: as we ſometimes ſee, that by the help of ſuch inſtructions unlearned perſons, and even old wives, do with ſome one ſovereign plaſter, balſam or other outward remedy, cure many and various tumours, ulcers, and other ſores, in perſons of differing ſexes, ages, and complexions. And becauſe you will eaſily grant, that this example does far leſs accommodate our preſent purpoſe than does the caſe it ſelf, as I juſt now put it; I hope you will allow me to repreſent further, that at leaſt it ſeems not ſo rational to judge of all the remedies, that art improving nature can afford us, by thoſe, that are hitherto in uſe, either among methodiſts or vulgar chymiſts; but rather to think, that the nobleneſs of remedies will be advanced according as the art of preparing them ſhall be promoted; and that it is not ſo ſafe and eaſy, poſitively to determine the efficacy of the former, otherwiſe than in proportion to the diſcoveries we have attained to in the latter.

The END *of the* FIRST VOLUME.

BOOKS Printed for and Sold by A. MILLAR, at *Buchanan's Head*, over-againſt *Katharine-Street* in the *Strand*, *London*.

FOLIO.

I. THE Works of FRANCIS BACON, Baron of *Verulam*, Viſcount *St. Alban*, Lord High Chancellor of *England*. With ſeveral *Additional Pieces*, never before printed in any Edition of the Works. To which is prefixed, A New Life of the Author, by Mr. MALLET. In 4 Vols.

N. B. The *Additional Pieces*, and *Life*, may be had alone, to compleat the former Edition.

II. A COMPLETE COLLECTION of the *Hiſtorical*, *Political*, and *Miſcellaneous Works* of JOHN MILTON: Correctly printed from the *Original Editions*. Containing ſeveral *Original Papers* of His, never *before* publiſhed. By T. BIRCH, M. A. and F. R. S. With an Hiſtorical and Critical Account of the Life and Writings of the Author:

To which is added, A Large Alphabetical Index, and a curious Head of the Author, engraven by Mr. VERTUE, from a Drawing by Mr. RICHARDSON. In 2 Vols.

III. The OCEANA and *Other Works* of JAMES HARRINGTON Eſq; Collected, Methodized, and Reviewed; with an exact Account of his Life prefixed, by *John Toland*. To which is added, An APPENDIX, Containing all the Political Tracts wrote by this Author, *omitted* in Mr. *Toland's* Edition.

N. B. The *Appendix* may be had alone, to compleat thoſe Gentlemen's Books, who have bought Mr. *Toland's* Edition.

IV. An HISTORICAL and POLITICAL DISCOURSE of the LAWS and GOVERNMENT of ENGLAND, from the *Firſt Times* to the End of the Reign of *Queen Elizabeth*. With a Vindication of the Ancient Way of Parliaments in *England*. Collected from ſome Manuſcript Notes of JOHN SELDEN Eſq; by NATHANIEL BACON, of *Gray's-Inn*, Eſq; The Fourth Edition: Corrected and improved by a Gentleman of the *Middle-Temple*.

N. B. There are a few of the above Four Books printed on a ſuperfine Writing-Paper.

V. A GENERAL DICTIONARY, *Hiſtorical* and *Critical*: In which a New and Accurate Tranſlation of that of the celebrated Mr. *Bayle*, with the Corrections and Obſervations printed in the late Edition at *Paris*, is included; and interſperſed with *ſeveral Thouſand Lives*, never before publiſhed. The whole containing the Hiſtory of the moſt Illuſtrious Perſons of all Ages and Nations, particularly thoſe of *Great-Britain* and *Ireland*, diſtinguiſhed by their Rank, Actions, Learning, and other Accompliſhments. With Reflections on ſuch Paſſages of Mr. *Bayle*, as ſeem to favour Scepticiſm and the *Manichee* Syſtem. By the Rev. Mr. JOHN PETER BERNARD, the Rev. Mr. THOMAS BIRCH, F. R. S. Mr. JOHN LOCKMAN, and *other Hands*. In 10 Vols.

VI. CYCLOPÆDIA: Or, *An Univerſal Dictionary of Arts and Sciences*; Containing an Explication of the Terms, and an Account of the Things ſignified thereby, in the ſeveral Arts, both Liberal and Mechanical; and the ſeveral Sciences, Human and Divine: The Figures, Kinds, Properties, Productions, Preparations, and Uſes of Things Natural and Artificial: The Riſe, Progreſs, and State of Things Eccleſiaſtical, Civil, Military, and Commercial: With the ſeveral Syſtems, Sects, Opinions, *&c.* among Philoſophers, Divines, Mathematicians, Phyſicians, Antiquaries, Criticks, *&c.* The whole intended as a Courſe of Ancient and Modern Learning. Extracted from the beſt Authors, Dictionaries, Journals, Memoirs, Tranſactions, Ephemerides, *&c.* in ſeveral Languages. By E. CHAMBERS, F. R. S. The Fourth Edition, corrected and amended; with ſome Additions. In 2 Vols.

VII. An UNIVERSAL HISTORY, from the Earlieſt Account of Time to the Preſent. Which comprizes not only the GENERAL HISTORY of the WORLD, but of each Empire, Kingdom and State, from its *Firſt Foundation* to its *Diſſolution*, or to the *Preſent Time*. With an exact Account of the Migrations and Conqueſts of every People, the Succeſſion and Reigns of their reſpective Princes, their Religion and Government, Trade, Cuſtoms, Learning, *&c.* The Whole forming a *Complete Body of Hiſtory*, and in itſelf an *Entire Library*, being a *Common-Place* of the various *Hiſtorians*, both *Ancient* and *Modern*, of all *Nations* and *People*, under their ſeveral *Forms* of *Government*, brought down to the *preſent Century*, properly *regulated* and *digeſted*. Immediately extracted from Original Authors, illuſtrated with Maps, Cuts, Chronological and other Tables.——Gentlemen may begin this Work by buying a Volume at a time, or be furniſhed with the whole Six Volumes.

N. B. This Undertaking is ſo well executed, and in ſuch Eſteem abroad, that it is tranſlated into ſeveral Languages in different Parts of *Europe*.

Vol. VII. *is in the Preſs, which finiſhes the Ancient Hiſtory.*

VIII. The HISTORY of LONDON, from its FOUNDATION by the *Romans*, to the PRESENT TIME. Containing a faithful Relation of the *Publick Tranſactions* of the CITIZENS; Accounts of the ſeveral *Pariſhes*; Parallels between *London* and *other great Cities*; its *Governments*, Civil, Eccleſiaſtical, and Military; *Commerce*, State of *Learning*, *Charitable Foundations*, &c. With the ſeveral Accounts of *Weſtminſter*, *Middleſex*, *Southwark*, and other Parts within the Bills of Mortality. In nine Books. The whole illuſtrated with twenty-five fine *Folio Cuts*, beſides 109 ſmall ones printed in the Body of the Work. With a complete Index. By WILLIAM MAITLAND, F. R. S.

IX. The BRITANNIC CONSTITUTION: Or the Fundamental Form of Government in *Great-Britain*. Demonſtrating the Original Contract entered into by King and People, according to the Primary Inſtitutions thereof in this Nation. Wherein is proved, That the placing on the Throne King WILLIAM III. was the *Natural Fruit* and *Effect* of the *Original Conſtitution*; and that the Succeſſion to this Crown, eſtabliſhed in the preſent Proteſtant Heirs, is *De Jure*, and juſtified by the Fundamental Laws of *Great-Britain*. And many important Original Powers and Privileges of both Houſes of Parliament, are exhibited. By ROGER ACHERLEY, late of the *Inner-Temple*, Eſq; The Second Edition. To which is added, A SUPPLEMENT, containing *Reaſons* for Uniformity in the State.

X. The Works of the learned ISAAC BARROW, D. D. late Maſter of Trinity-College, *Cambridge*: Being all his *Engliſh* Works. The Fifth Edition. In 3 Vols. Containing, in Vol. I. Thirty-two Sermons, preached upon ſeveral Occaſions; a brief Expoſition of the Creed, the Lord's Prayer, Decalogue, and the Doctrine of the Sacraments. A Treatiſe of the Pope's Supremacy; and a Diſcourſe on the Unity of the Church Vol. II. Thirty-four Sermons and Expoſitions upon all the Articles in the Apoſtles Creed. Vol. III. Forty-five Sermons upon ſeveral Occaſions. With Tables of Contents to each Volume. The whole publiſhed by his Grace Dr. JOHN TILLOTSON, late Lord Archbiſhop of *Canterbury*. To which is prefixed, Some Account of the Life of the Author.

OCTAVO.

XI. The Works of Mr. THOMSON, in 2 vols. with Cuts. Containing the *Seaſons*, a *Hymn*, a Poem to the Memory of Sir *Iſaac Newton*, *Britannia*, a Poem, and *Sophoniſba*, a Tragedy. Vol. II. Ancient and Modern *Italy* compared; *Greece*, *Rome*, *Britain*, and the *Proſpect*, being the Five Parts of *Liberty*, a Poem; *Agamemnon*, and *Edward* and *Eleonora*, Tragedies; and a Poem to the Memory of the late Lord Chancellor *Talbot*.

N. B. Either of the Volumes are to be had ſeparate, and moſt of the Pieces

XII. MATHO: Or, The *Coſmotheoria Puerilis*. A Dialogue. In which the firſt Principles of Philoſophy and Aſtronomy are accommodated to the Capacity of young Perſons; or ſuch as have yet no Tincture of theſe Sciences. Hence the Principles of Natural Religion are deduced. In 2 Vols.

XIII. An ENQUIRY into the *Nature* of the *Human Soul*; wherein the Immateriality of the Soul is evinced, from the Principles of Reaſon and Philoſophy. In 2 Vols. The Second Edition, corrected. By the Author of *Matho*.

" He who would ſee the juſteſt and preciſeſt Notions
" of God and the Soul, may read this Book; one of
" the moſt finiſhed of the kind, in my humble O-
" pinion, that the preſent Times, greatly advanced
" in true Philoſophy, have produced."

See Warburton's *Divine Legation of* Moſes *demonſtrated, p.* 395. *of the firſt Edition.*

XIII. The HISTORY of the *Propagation* of *Chriſtianity*, and the Overthrow of *Paganiſm*: Wherein the *Chriſtian Religion* is confirmed; the Riſe and Progreſs of Heatheniſh Idolatry is conſidered; the Overthrow of Paganiſm, and the ſpreading of Chriſtianity, in the ſeveral Ages of the Church, is explained; the preſent State of the Heathens is enquired into; and Methods for their Converſion propoſed. In 2 Vols. The Third Edition corrected, with Additions. By ROBERT MILLAR, A. M. *The Biſhop of* London, *in his Paſtoral Letters, p.* 133. *recommends this Book as written by a faithful and judicious Hand.*

Digitized with financial assistance from

Shri Brihad Bhartiya Samaj

on 20 February, 2020